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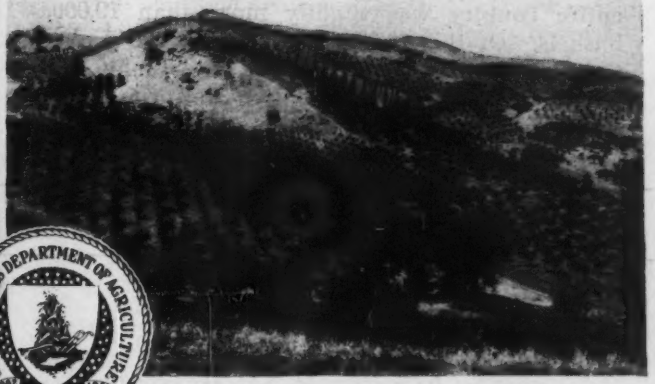
PLUM and PRUNE GROWING in the PACIFIC STATES



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IN ITS VARIOUS FORMS the plum is more widely distributed throughout the country than any other tree fruit, though in value the plum crop of 1919 (Fourteenth Census) was exceeded by that of four other fruits—the apple, peach, orange, and grape. The great range of distribution, however, is mainly incident to the great diversity that occurs in the species of native wild plums, cultivated horticultural varieties of which are found in almost every nook and corner of the country.

Though the native plums give vastness in range of plum culture in general, it is the domestica or European varieties, the Japanese sorts, and those which have originated as hybrids between Japanese and native plums that constitute the commercial industry. Prunes are included in the domestica or European group. Some of the Japanese and hybrid varieties are grown very widely, possibly as widely as the varieties of any one species of native plum.

Though this bulletin is regional in its direct application, it has to do with a very large part of the plum and prune industry. The crop of 1919 for the entire country was slightly more than 19,000,000 bushels. Of this 16,624,000 bushels were grown in California, Oregon, Washington, and Idaho. Practically two-thirds of all the plum and prune trees in the country on January 1, 1920, were in these States.

Washington, D. C. Issued August, 1924

PLUM AND PRUNE GROWING IN THE PACIFIC STATES.[1]

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CONTENTS.

	Page.		Page.
Plum and prune growing regions	1	Distance for planting	33
Central California valleys lying west of the Coast Range	4	Nursery trees for planting	36
Interior valleys of central California	6	Time for planting	38
Western Oregon and western Washington	8	Orchard culture	38
Eastern Oregon, eastern Washington, and Idaho	11	Irrigation	41
The choice of locality and site for a plum orchard	12	Cover crops	45
Varieties	20	Intercrops	48
Pollination	25	Pruning	49
Stocks used in propagating plum trees	26	Fruit thinning	54
Top-working	28	Propping and bracing	55
		Fertilizers	55
		Fruit harvest	55
		Diseases and insects	57

PLUM AND PRUNE GROWING REGIONS.

The area which may be utilized for the culture of plums and prunes in the Pacific States is very much limited when compared with the gross area of these States, as orcharding is restricted to tillable lands which are under irrigation or to locations where the winter rainfall is sufficient for the needs of the trees.

These requirements have resulted in limiting the commercial growing of this crop to certain sections, although in those sections plums and prunes are among the most important fruits produced. These sections, widely separated in distance and in climatic conditions, are discussed here separately as far as possible. Natural geographical

[1] In this bulletin the plum and prune are considered one fruit, and botanically the European or domestica plum and the prune belong to the same species, *Prunus domestica*. The cultural methods are the same, but the methods of harvesting and handling the fruit are or may be different, depending on the use to which the fruit is put. The use of the terms "plum" and "prune" dates back for several centuries. The words come from different sources, one being Anglo-Saxon, the other French. Originally they doubtless were synonymous in meaning. At what date the term "prune" was first used to designate a "dried plum" or a plum capable of being dried into a product having certain desirable characteristics is uncertain; however, this term has come to signify a plum which is capable of being dried without fermenting when the pit is not removed. The term also signifies the dried as well as the fresh fruit. A prune, therefore, is substantially a variety of plum which possesses certain peculiar characteristics. Most plums, if dried with the pits remaining in them, would ferment in the process. Prunes, in the fresh state as compared with plums, usually possess a firmer, drier flesh, a higher content of sugar, frequently a higher acid content, and are liable to be rather astringent until very ripe; in other words, a prune is a plum having these characters in a more marked degree than other plum varieties. Large quantities of fruit which could be dried to prunes are sold in the fresh state; they are then handled in identically the same way that plums are handled. Plums are sometimes dried after the pits are removed, but the product is called "dried plums," not "prunes." In case of varieties that can be dried to prunes, the fruit in the fresh state, as indicated above, is often called a prune; and in some instances the word "prune" is a part of the variety name, as the Italian prune or German prune.

XUM

divisions are used for boundaries of the regions where phases of the industry, such as marketing and cultural methods, differ sufficiently to warrant separate consideration.

The boundary of each of these regions to which some phase of the industry is peculiar is determined largely by prevailing temperatures, although, within a given region, soil conditions and the availability of water for irrigation result in considerable divergence in methods of carrying out details in orchard management. Although this crop (plums and prunes considered collectively) may be found in home orchards of all sections of the Pacific States, four geographical districts may be said to include the principal commercial producing areas of this fruit. These are (1) the central California valleys lying between the Coast Range of mountains and the Pacific Ocean, including the Santa Clara, Napa, and Sonoma Valleys and their tributary valleys and adjacent foothills; (2) the interior valleys of central California, including the Sacramento, San Joaquin, and tributary valleys, and the bordering slopes and foothills; (3) the principal river valleys and the adjacent rolling lands of western Oregon and western Washington, including the Willamette, Columbia, and Umpqua River valleys; and (4) the irrigated valleys of southeastern Washington, northeastern Oregon, and the Snake River valley region of Idaho. With this last section is included also the region of east-central Washington and the bordering portion of Idaho known as the Palouse region, which lies in the same geographical district as southeastern Washington, although cultural practices differ decidedly in the two sections. In Table 1 the more important counties in the different areas are listed, together with the number of trees not of bearing age, those of bearing age, and the total number in each county.

TABLE 1.—*Plum trees in the Pacific States, by counties, districts, and States.*

[Figures taken from the Census of 1920. Only counties with more than 5,000 trees are included in calculating district plantings.]

CENTRAL CALIFORNIA COAST DISTRICT.

County	Trees not of bearing age.	Trees of bearing age.	Total.	County.	Trees not of bearing age.	Trees of bearing age.	Total.
Alameda	50,182	145,114	195,296	Napa	344,411	449,866	794,277
Contra Costa	42,808	61,497	104,305	Sonoma	877,983	854,411	1,732,394
Monterey	4,811	10,503	15,314	Marin	4,557	4,187	8,744
San Benito	154,322	145,311	299,633				
San Mateo	273	6,043	6,316	Total for district	2,870,149	5,151,522	8,021,671
Santa Clara	1,354,155	3,371,436	4,725,591				
Santa Cruz	36,647	103,154	139,801				

INTERIOR VALLEYS OF CENTRAL CALIFORNIA.

Amador	3,864	40,541	44,405	Sacramento	132,600	233,237	365,837
Butte	196,164	268,270	464,434	San Joaquin	111,875	94,222	206,097
Calaveras	356	7,785	8,141	Shasta	31,921	71,437	103,358
Colusa	134,670	101,709	236,379	Solano	162,160	609,755	771,915
Eldorado	15,310	47,211	62,521	Stanislaus	17,787	18,333	36,120
Fresno	109,141	120,963	230,104	Sutter	319,609	159,002	478,611
Glenn	93,731	34,342	128,073	Tehama	69,797	94,526	164,323
Kern	20,176	19,005	39,181	Tulare	269,009	422,228	691,237
Kings	50,830	49,829	100,659	Yolo	93,541	152,485	246,026
Madera	11,381	3,547	14,928	Yuba	40,055	11,065	51,120
Merced	7,512	7,235	14,747				
Nevada	5,084	16,740	21,824	Total for district	2,139,705	3,287,060	5,426,765
Placer	243,132	703,593	946,725				

TABLE 1.—*Plum trees in the Pacific States, etc.*—Continued.

WESTERN OREGON AND WESTERN WASHINGTON.

County.	Trees not of bearing age.	Trees of bearing age.	Total.	County.	Trees not of bearing age.	Trees of bearing age.	Total.
Oregon:				Washington:			
Benton	17,579	76,569	94,148	Clarke	179,881	507,762	687,643
Clackamas	44,545	112,001	156,546	Cowlitz	1,810	10,891	12,701
Douglas	222,616	503,842	726,458	Skamania	6,745	6,969	13,714
Lane	63,319	139,816	203,135	King	2,352	18,755	21,107
Linn	28,965	109,289	138,254	Pierce	1,827	14,345	16,172
Marion	155,745	607,520	763,265	Thurston	250	11,302	11,552
Multnomah	2,544	18,836	21,380	Lewis	2,535	21,969	24,504
Polk	334,973	518,165	853,138	Snohomish	2,425	13,219	15,644
Columbia	600	7,307	7,907	Whatcom	2,095	14,336	16,431
Washington	73,306	150,923	224,229	Skagit	1,237	7,653	8,890
Yamhill	268,213	494,993	763,206	Wahkiakum	316	1,038	1,354
Jackson	1,316	15,995	17,311	Mason	335	2,642	2,977
Josephine	197	11,675	11,872	Kitsap	1,413	5,914	7,327
				Clallam	455	2,125	2,580
Total, western Oregon	1,213,918	2,766,931	3,980,849	Pacific	423	1,366	1,789
				Total, western Washington	204,099	640,286	844,385
				Total for district	1,418,017	3,407,217	4,825,324

EASTERN WASHINGTON, EASTERN OREGON, AND IDAHO.

Washington:				Idaho:			
Benton	6,722	10,634	17,356	Ada	16,367	211,064	227,431
Chelan	8,250	11,642	19,892	Bingham	655	5,085	5,740
Douglas	2,169	3,715	5,884	Canyon	28,502	46,584	75,086
Garfield	559	6,193	6,752	Cassia	636	7,685	8,321
Spokane	2,634	33,608	36,242	Elmore	1,305	24,724	26,029
Stevens	581	8,843	9,424	Gem	3,127	62,847	65,974
Walla Walla	30,785	31,299	62,084	Gooding	3,513	7,174	10,687
Whitman	4,958	28,446	33,404	Idaho	559	8,425	8,984
Yakima	39,774	68,361	108,135	Jerome	1,577	7,050	8,627
				Kootenai	842	7,334	8,176
Total, eastern Washington	96,432	202,741	299,173	Latah	2,015	20,276	22,291
				Nez Perce	1,486	8,198	9,684
Oregon:				Owyhee	779	5,543	6,322
Baker	417	5,038	5,455	Payette	4,727	59,267	63,994
Malheur	1,529	32,562	34,091	Twin Falls	2,858	21,825	24,683
Umatilla	91,522	110,218	201,740	Washington	5,060	18,215	23,275
Union	7,613	26,912	34,525				
Wallowa	1,291	4,194	5,485	Total, Idaho	74,008	521,296	595,304
Wasco	10,388	26,803	37,191	Total, eastern Washington	96,432	202,741	299,173
Total, eastern Oregon	112,760	205,727	318,487	Total, eastern Oregon	112,760	205,727	318,487
				Total for district	283,200	929,764	1,212,964

SUMMARY OF PLANTINGS OF PLUMS BY STATES.

State:				State:			
California	5,237,145	8,768,436	14,005,581	Idaho	80,485	552,595	633,080
Oregon	1,331,606	2,999,480	4,331,086	Total	6,958,466	13,195,874	20,154,340
Washington	309,230	875,363	1,184,593				

Plums are grown commercially also in southern California, principally in Los Angeles and Riverside Counties, but here they are not among the more important fruit crops. In the four divisions specified in Table 1 there is produced almost the entire commercial output of plums and prunes in the Pacific States, although the plum is widely planted for home use, and a large list of varieties is repre-

sented in the home orchard in all fruit-growing localities of these States.

In each of the four main districts some phase of plum culture is practiced which is for the most part distinct from that of the other districts, these differences being made necessary by the peculiar climatic conditions of the district. The main features in the culture of this crop which are peculiar to each district may be summarized as follows:

(1) The valleys of central California west of the Coast Range include the principal centers in this country for the production of the Agen, commonly called the French prune or Petite prune, and of the Imperial Epineuse prune. In this district these varieties are grown in far greater quantity than all other varieties combined, and owing to the warm, dry fall climate almost the entire crop of prunes is dried in the open air. A considerable portion of the orchards in this district is under irrigation.

(2) The interior valleys of California produce plums both for shipping fresh and for making into prunes. Practically all the varieties of plums and prunes grown in the Western States are represented here. Almost the entire acreage in this district is under irrigation.

(3) In western Washington and western Oregon the Italian prune and the Agen are the only varieties of wide commercial importance among the rather small list grown, the Italian prune being decidedly the more important of the two. The entire output of prunes is dried by artificial means. Practically all orchards of this district are grown without irrigation.

(4) In the district east of the Sierra Nevada Mountains, including southeastern Washington, northeastern Oregon, and Idaho, the Italian prune is by far the most important variety, almost the total crop being shipped fresh to distant markets. The entire acreage in this district is under irrigation except in the Palouse region, where the Italian prune is the only commercial variety and all orchards are maintained by dry-farming methods. The fruit in the Palouse region is usually dried into prunes and by artificial means, but some fresh fruit is shipped to distant markets.

For convenience in describing the commercial distribution, the prevailing cultural practices, and the economic conditions in plum culture, the districts above mentioned are considered separately.

CENTRAL CALIFORNIA VALLEYS LYING WEST OF THE COAST RANGE.

This district includes the cultivated areas of the Santa Clara, Sonoma, and Napa Valleys and their tributaries, or the valley areas of Santa Clara, San Mateo, San Benito, Sonoma, and Napa Counties. Varieties for prune making are grown throughout these valleys and to some extent throughout the adjacent lower slopes and foothills, with centers of production near San Jose, Napa, and Healdsburg. But few plums for the fresh market are grown here, while a considerable quantity is grown for canning. (Fig. 1.)

During the past 50 years plum growing in this district has been gradually increasing, except for a few interruptions due to low prices of the product. It is now the principal industry, and the large area of trees not of bearing age, equaling almost half the present bearing area, indicates the present rapid expansion of the industry.

The Santa Clara Valley, the first center of the prune industry in this country, is still the principal center of production, with nearly 4,750,000 trees, or more than half the prune trees in the district, mostly in Santa Clara County. Nearly one-fourth of the prune trees in this district are in Sonoma County.

The soils devoted to plum and prune production in these valleys are, for the most part, the deep fertile loams and sandy loams which

are darkened by a moderate humus content and are easily handled, productive, well drained, and enduring in nature. Small areas of adobe soil are found which require special tillage methods, and in certain sections the soil moisture becomes excessive in some years, requiring drainage for the most satisfactory tree development. The summers are long and warm, and, as in all fruit-growing sections of the Pacific States, the summer rainfall is exceedingly light and is disregarded through the plum-growing season. Irrigation is practiced wherever water is available and facilities for its application have been provided. During the period for drying fruit, in September and early October, occasional interruptions are caused by rains, which make it necessary to stack the drying trays, and even with this precaution the loss of fruit is not always avoided and is sometimes considerable. With ordinary caution, however, in most years the

FIG. 1.—Orchard of Agen (*French prune*) prunes growing in a fertile valley soil. (Healdsburg, Calif., September, 1921.)

crop may be dried in the open with but little, if any, loss. As an insurance against damage by rains a number of artificial driers have been erected. The temperature throughout the prune-growing sections of this district is very much the same through the fruit-growing season, except that the daily range is somewhat greater during the warmest part of the summer in the portions of the main valleys which are farthest from San Francisco Bay.

Aside from the Agen, which is the principal variety in all sections of this district, the Imperial Epineuse is grown to a considerable extent in the Sonoma Valley, especially in the plateaus bordering the valleys near Healdsburg. Throughout the district the Sugar and the Standard are varieties of some importance. The culture of plums for shipping fresh is not an important industry here, mainly owing to insufficient warmth during the early summer to ripen them

XUM

so that they may be marketed in competition with the plums from sections where they ripen earlier. In some localities of this district there is also a lack of water for irrigation, which is needed to produce fruit of the larger sizes suitable for shipping. A few orchards are maintained to supply plums for canning.

INTERIOR VALLEYS OF CENTRAL CALIFORNIA.

The interior-valley district includes the Sacramento and San Joaquin Valleys of California and their bordering slopes and tributary valleys. Plantings which total more than 5,000,000 trees are found in all localities of this district where plums and prunes are cultivated, with three-fourths of the plantings in the Sacramento Valley. The largest centers of production are the Loomis-Auburn section of Placer County, the vicinity of Vacaville in Solano County, the Hood–Walnut Grove section of Sacramento County, in Tulare County, along the Feather River in Sutter County, and near Chico in Butte County. One-third of the plum trees in this district are in the first two sections mentioned. Fresno and San Joaquin Counties also

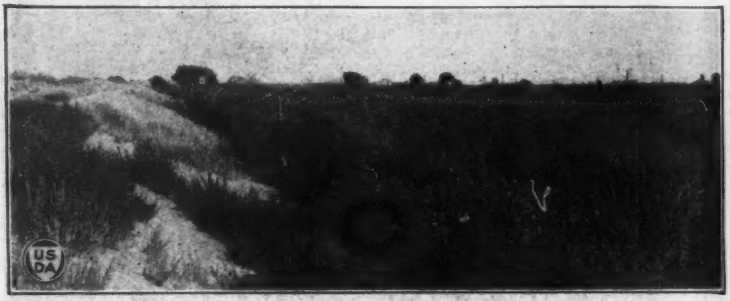

FIG. 2.—A plum orchard on delta land in the lower Sacramento Valley, Calif. Note the close planting and vigorous growth of the trees. A small portion of the road on the river levee is shown at the left. (July, 1921.)

have a large acreage devoted to this fruit, and all other counties of the district include it among their fruit crops.

The plums which ripen first in the Pacific States are produced in the large plum-growing sections of this district where there are extensive plantings of early-maturing varieties. The first harvests are made in the foothills of Solano County, near Vacaville, where fruit of the earliest varieties is shipped to eastern markets during the last of May. The harvest in the valley near these foothills and in the foothills of Placer County starts but a few days later and is followed closely by that in the sections through the main valleys.

While the low winter temperatures are approximately the same throughout the district, the localities where the earliest fruit is produced are naturally protected in the spring from the cool, moist breezes which sweep through the main portions of the lower valleys, and their surface soils are well drained, friable, and absorb and retain heat well. These conditions result in the early blossoming of the trees and the rapid development of the fruit.

Plums both for fresh shipment and for prune making are grown extensively in all the fruit-growing centers of the district except in

Placer County, where the entire output is fresh fruit, and in the Hood–Walnut Grove section, where almost the entire output is fresh fruit. In the latter section small plantings of canning fruit are maintained. Aside from these localities, which are the most important sections in California for the production of plums for fresh shipment, the Vacaville section is the center of heaviest production. Two-fifths of the plum trees of this district are still under bearing age. Vast areas suitable for this fruit are now occupied by annual crops or are not under cultivation, a result largely of the lack of irrigation systems.

The soils devoted to plum culture in this district are those of the deep, fertile, alluvial types in the valley bottoms. (Fig. 2.) In the higher lands there is a wide range of type varying from heavy deep loams to sandy and gravelly soils, where the underlying stone is sometimes covered with only a shallow layer of tillable earth. Soils underlain near the surface by hardpan, which occupy broad areas in the

FIG. 3.—Plum orchards on the rolling lands near Vacaville, Calif., in July, 1921. The season's earliest fresh-fruit shipments to eastern markets are made from orchards on these lands.

main valleys, are avoided almost entirely for varieties for prune making and are naturally unsuited to varieties for fresh shipment. Soils derived from granite and some types of sandstone, such as are sometimes found in the rolling foothills bordering the large valleys, are in demand even where the stratum of tillable soil is not deep.

Notable among the nonirrigated sections is the rolling area near Vacaville, in Sonoma County (fig. 3), where the foothill soils are derived from and underlain with sandstone. If properly tilled, these soils are sufficiently retentive of moisture to produce profitable crops of fruit without irrigation. As no water is available for irrigation in this section, dry-farming methods are practiced, and the earliest ripening fruit is grown.

In this district the summers are long, hot, dry, and well suited to the early ripening of plums as well as for the satisfactory development of prunes. As a rule, the summer drought continues well into the autumn, so that prunes may be dried in the sun without loss from fall rains. The early warmth in the spring causes the trees

XUM

to blossom early, and some injury by frost, at least to the early-blooming varieties, is not uncommon in the lowlands. Here the annual rainfall varies considerably from year to year, but there are no rains during the fruit-growing season. Irrigation is therefore imperative in the shallower soils and highly desirable on the deeper valley soils not moistened by subirrigation. In some places in the Hood–Walnut Grove section of the lower Sacramento Valley, orchards are usually plentifully supplied with moisture by subirrigation.

As in the valleys near the coast which were just discussed, the Agen variety is by far the most important for prune making, although orchards of the Imperial Epineuse, Standard, Sugar, and Sergeant (*Robe de Sergeant*) are occasionally found. Almost all varieties of plums grown commercially in the Pacific States for fresh shipment are found here in considerable quantities.

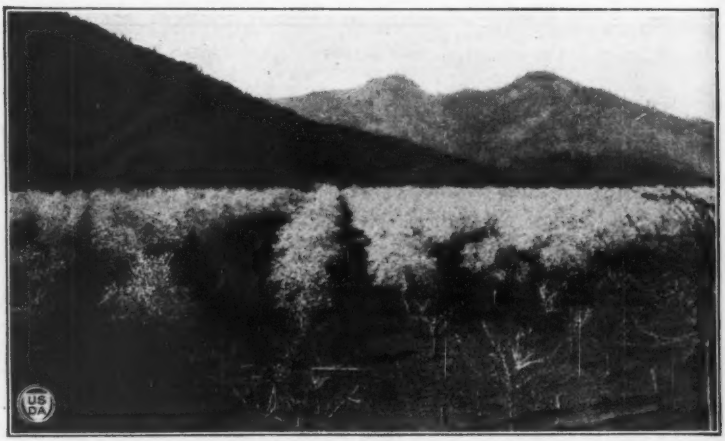

FIG. 4.—A prune orchard in bloom in a rather narrow valley location. (Umpqua Valley, Douglas County, Oreg.)

WESTERN OREGON AND WESTERN WASHINGTON.

The principal commercial plum-growing centers of this district lie in the cultivated areas between the Cascade and Coast Ranges in western Oregon and west of the Cascade Mountains and the Puget Sound region of Washington. Until the late eighties plum growing was a minor industry in this district, but about that time it became popular and most of the older orchards were established. Plantings were not greatly increased until the past few years, when many orchards were established or old ones enlarged.

The census report for 1920 gives 3,980,849 plum trees in western Oregon, 2,766,931 of which are of bearing age. The principal regions where plums are found are in the vicinity of the Willamette River in Polk, Marion, and Yamhill Counties, having over 750,000 prune trees each, with centers near Salem, Dallas, and Newberg, and in the Roseburg-Riddle section of the Umpqua River Valley in Douglas County, where the plantings are about the same in extent as in the

different counties farther north just mentioned. More than three-fourths of the prune trees in western Oregon are in these four counties.

In western Washington, where according to the Fourteenth Census 844,385 trees were found, the principal plum-producing region is the Vancouver-Camas-Washougal section of Clarke County. Here nearly 700,000 trees are under cultivation.

The greater portion of the orchards in the Umpqua Valley are in the bottom lands near the river, while in the Willamette River Valley region the rolling lands have been as much favored as the low valleys for prune production. (Fig. 4.) Many growers have given preference to the broken, rolling lands which reach 500 or more feet above the river bottom. (Fig. 5.) In the prune-producing sections of Washington just mentioned, both the flat lands near the Columbia River and the rolling lands extending back several miles from it and in the Puget Sound region are used.

FIG. 5.—A typical site of a prune orchard in the broken rolling section of northwestern Oregon. (August, 1921.)

Many soil types are represented in the orchards of this district. Through the sections in Oregon brownish or reddish clay loams predominate, with subsoil heavier in texture but of the same material, which has been derived from the basalt rock with which it is underlain. In the lower valleys, notably that of the Willamette River, the humus content is rather high and the soil is loosened and darkened by it. This soil is deep and retentive of moisture. Through the red and brown soils of the rolling orchard sections the humus content is low, and the surface soil dries out rather quickly and is sticky when wet. When cultivated while too wet it forms compact clods, which are very hard when dry, but if tilled when in proper condition it works up into a light loam of excellent quality.

The surface soils in the plum-growing sections of southwestern Washington are, for the most part, sandy or gravelly loams, light brown, brown, and gray in color, underlain at a varying depth of about 3 feet and over with a deep stratum of very coarse gravel. This soil is easily tilled but not retentive of moisture because of the

XUM

perfect subdrainage. In the prune-producing sections farther back from the Columbia River the subsoils are finer in texture and more compact, and therefore more retentive of moisture. Soils built up by washings from the Columbia River and similar soils of the rolling section to the northeast of Vancouver Lake in Clarke County, Wash., are deep, fertile, fairly retentive of moisture, and are prized for prune production. (Fig. 6.)

In this district the rainfall is heavy during the fall, winter, and early spring, but drought prevails during the summer, the same as in most cultivated areas of the Pacific States. Almost no irrigation is practiced in this district, although the need for moisture is apparent during the late summer throughout most of the large orcharding areas, especially in rolling sections where the humus content is low and in places where the substratum of coarse gravel comes to

FIG. 6.—A comparatively old orchard of the Italian prune in Clarke County, Wash., near Vancouver. Trees planted 20 by 20 feet. The orchard has been well fertilized and tilled and produces well. (August, 1921.)

within a few feet of the surface. There is some variation in the length of the dry season in different years. The rains sometimes start while the prune harvest is in progress and occasionally continue in the spring until the trees are in blossom. Injury to the crop results in either case.

Low temperatures have caused serious injury to the trees in northwestern Oregon and southwestern Washington, at least in the lowlands. The summers in this district are warm, but several degrees cooler than in the central California valleys and somewhat cooler than in the plum-growing centers of the valleys of California near the coast or of those of eastern Washington, eastern Oregon, and Idaho.

No plums are shipped fresh to the eastern markets from this district because of the moist atmosphere at harvest time, with the re-

sulting prevalence of brown-rot. A few are grown for the local markets and for canning, but almost the entire crop is dried into prunes. The total output of prunes is cured artificially, owing to the moist fall weather, which makes open-air curing impracticable.

The planting of plums has been confined largely to the Italian prune variety, although a number of orchards of the Agen (or the Petite prune, as it is commonly called in the Northwestern States) are found. The proportion of the Agen prune is greater in Oregon than in Washington, especially in Douglas County, where, in the Myrtle Creek–Riddle section, it is grown almost to the exclusion of other varieties. There are a few orchards of Sugar, Imperial Epineuse, and Standard prunes, but the output of these varieties is not important at present.

EASTERN OREGON, EASTERN WASHINGTON, AND IDAHO.

The planting of commercial orchards of plums in the district has been confined almost entirely to the irrigated valleys, with important centers of production near Walla Walla, Wash.; the Milton-Freewater section of Walla Walla County, Wash.; in Umatilla County, Oreg.; the Yakima Valley in Yakima County, Wash.; and the Weiser-Emmett-Boise section in southwestern Idaho. Prunes are grown commercially, but not very extensively, in northern Wasco County, Oreg., near The Dalles; in eastern Whitman and southeastern Spokane Counties, Wash., and the bordering portion of Idaho, known as the Palouse region. There is no water available for irrigation in the last two sections, but orchards are maintained by dry-farming methods. Since the early nineties, when the major portion of the oldest plum orchards of this district were established, the growth of the industry has been slow until within the past few years, when extensive plantings were made. The census for 1920 gives nearly 1,500,000 plum trees for this district, of which slightly less than 1,000,000 are of bearing age. In the Palouse region the number of young trees considerably exceeds that of trees of bearing age.

In southwestern Idaho there are approximately 595,000 trees, in eastern Washington 300,000, and in eastern Oregon 320,000. The trees under bearing age in this district include two-fifths of the entire planting. The Walla Walla, Milton-Freewater, and Yakima sections are centers where extensive new plantings have been made during the past few years. The increase is less marked in the fruit-growing portions of Idaho.

The soil in which fruit is grown in this district is, for the most part, a fertile, friable, easily tilled sandy loam of varying depth and organic content. It is everywhere sufficiently deep for good tree growth, and in some places, notably in the Yakima Valley, it is exceedingly deep. The surface soils are open and well drained, and the subsoils in most places are composed of stratified materials and are well drained also.

The sections from which plums are shipped from this district are semiarid to arid in nature. The summers are somewhat shorter than in the plum-growing sections of western Washington, western Oregon, and California, and the days are hotter than in western Oregon and western Washington, with the daily range of temperature greater. The rainfall is light, nearly all of it occurring from Sep-

XUM

tember to April. The total precipitation is considerably less than in the other districts described, except in the Palouse region, where practically all the plums are shipped fresh. The fruit reaches good size and, owing to dry weather which usually prevails at harvest time, may be successfully shipped to distant markets.

In the Palouse region, where the prevailing summer temperatures are low, the rainfall light, and only moderate cultivation is given, the fruit is usually below the sizes sent to the market fresh. A portion of the fruit from this region is shipped fresh when the prices for fresh fruit are high or the fruit for the season is above the average in size.

As in the sections farther west, the Italian prune is by far the most widely used variety for commercial plantings. A considerable number of orchards of Pond and Tragedy are found, also occasional plantings of Reine Claude (*Green Gage*), Peach, Tennant, and a few other varieties. The greatest acreage of varieties other than the Italian prune is found in the Yakima and Walla Walla sections. An occasional orchard of Agen is found in these sections and in the Boise, Idaho, section. All of these commercially grown varieties are of the *Prunus domestica* group. Japanese varieties or Japanese-American hybrids have been planted in an experimental way only. The new plantings of these little-grown varieties are very few. The fruit of the Tragedy variety develops well here, but has not been a consistent cropper. Trees of the Pond have been prolific, and the variety is considered profitable.

The harvest of the Italian prune for fresh shipment in this district starts about August 10 in the section near The Dalles, Oreg., and is followed in a week or so by that from the main irrigated centers. In the Palouse region the fruit ripens late and is allowed to remain on the tree until the growing season ends and sometimes until after sharp frosts have occurred, when it falls or is easily shaken to the ground and is gathered for artificial drying.

In case of an unsatisfactory market for fresh fruit or if the fruit is small in size, a part of the crop is dried in all the main plum-growing centers of this district. All fruit for drying is processed by artificial means, the work often being done in central desiccating plants rather than in the small individual orchard driers.

THE CHOICE OF LOCALITY AND SITE FOR A PLUM ORCHARD.

The plum is adapted to a wide range of soil and climatic conditions and is found in all sections where fruits are grown in the Pacific States. Prevailing temperatures in fruit-growing sections of this region are for the most part suited to commercial plum culture, though the rainfall is sparse during the summer, irrigation being necessary in some localities. After the establishment of means of transportation through rural districts to central markets and the providing of means for irrigation, some points which require consideration are the selection of the proper soil type, the contour suitable for orcharding, and the locality where temperatures are congenial to the development of the variety the orchardist wishes to plant. Varieties grown for early fresh-fruit shipment are usually not types which sell well in the market with later-maturing varieties and therefore should be planted where natural conditions favor

their early ripening. Also, varieties grown for their dried product must be planted in places having a long growing season. Where fruit is for fresh shipment, not only the size of fruit must be considered but also the possibility of loss from brown-rot. The climate must be sufficiently free from moisture at harvest time to insure the fruit arriving in market without loss from decay in transit. The choice of a location and site for an orchard is then largely dependent upon the particular market in which the grower wishes to sell his product.

SOILS.

Plums are not particularly sensitive as to soil provided it is reasonably deep and fertile. They are found growing on a great number of soil types. The Japanese or American-Japanese hybrids, which make up a large acreage of plums grown for fresh-fruit shipment in California, will succeed on a soil more shallow and somewhat thinner than varieties of the *Prunus domestica* group, especially those which are grown for prune making. For the latter, only deep, fertile, well-drained land should be used, the heavier clay loams being preferable to the sandy loams. Soils which are underlain near the surface with hardpan should be avoided for plum culture.

Plum plantings for the most part have been made on soils derived from volcanic materials which have been laid down by sedimentation through the irrigated sections of Idaho, Washington, and Oregon; on the residual reddish clay loams and dark valley soils which have been filled in by washings from this type in western Washington and western Oregon; while in California, where the culture of this fruit has been greatly diversified, many different soils are used. However, for the production of prunes plantings here are confined almost entirely to the deep, dark, heavy loams such as are preferred by pear growers and which have been washed into the valleys from the surrounding hills. All varieties of plums for fresh-fruit shipment are grown in the valleys as well as on more upland soil, while those grown for their dried fruit are seldom planted on the more shallow uplands, where early shipping plums do well and have been extensively planted. For plums for fresh shipment, the more shallow, upland soils are not used except under irrigation or unless the soil type is such that it is very retentive of moisture, since a liberal supply of soil moisture is essential to the development of the large sizes demanded by the market for early plums. Notable among nonirrigated, rolling lands where plums for fresh shipment are grown is the rolling, hilly country lying in the immediate vicinity of Vacaville, Calif. Here the friable sandy loam, which is residual in origin, is well drained and open and warms quickly in the spring, and the subsoil and underlying sandstone, from which the soil has come through disintegration, is retentive of moisture, making natural conditions highly suited to the early ripening of fruit. In this region the summers are hot and dry, but the soil moisture is sufficient to bring a moderate crop of fruit to a desirable marketable size. Under these conditions the crop ripens several days earlier than in the immediately adjoining lower valley, where the deep fertile soil is more compact and slower in warming up in the spring. On the thinner soils of the hills, however, the tree growth is less than in the valley, and the crops are not so heavy as in the deeper soil.

XUM

In Placer County, Calif., there are 946,725 plum trees grown for the production of fresh fruit. This county is situated on the western slope of the Sierra Nevada foothills, where the soil as a rule is not deep and is low in organic matter, but is open, friable, well drained, and under good cultural methods retentive of moisture. It is derived by the weathering of granite bed rock and is a sandy, gravelly loam, varying considerably in depth. Outcroppings of granite occur occasionally through the orchards, while good soil to the depth of 6 feet or more is commonly found. While plum growing is extensive in each of the localities just described, varieties for prune making have been planted very sparingly.

In the deep fertile alluvial soils of the lower portions of the valley of central California plums for both fresh shipment and

FIG. 7.—An old orchard of the German prune on deep fertile river valley soil. The spread of the tree in the foreground is 34 feet. These trees were originally spaced 20 feet each way. The diagonal rows of trees have been removed and pear trees, which are more upright in their habit of growth, are planted in their places.

drying for prunes are grown side by side with equal success. (Fig. 7.) Here the climatic factor is the one which influences the planter most in his choice of crops. In the interior valleys, where the climatic and marketing conditions are suitable, both plums and prunes are widely grown. On soils of the same general nature in the valleys near the coast, climatic conditions cause a later harvest of plums for fresh shipment, and as a result they are but sparingly planted. Here prune production is the most extensive phase of fruit culture.

The principal soils used for plums in western Washington and western Oregon are the deep, enduring types of both residual and sedimentary origin. In these soils the organic content is low except in the river bottoms, and when dry the soil is hard and difficult to cultivate. In a few smaller centers the soils are shallow, inclined

to be heavy, and not conducive to a large tree growth or regular production of good crops. In the eastern part of these States and in Idaho, orchards are found mostly in the deep sandy loams of sedimentary origin where the settling of volcanic material has been an important factor in the formation of the surface soil, as in the Yakima Valley of Washington. These grayish mellow soils are easily tilled, very fertile, and fairly retentive of moisture when well cultivated. Where they are of sufficient depth they are suited to plum and prune production, as both good size and a development that insures a good dried product are obtained.

Strata of hard, compact material or hardpan are often found within a foot or two of the surface in some types of sedimentary soils. The grayish open surface soil in such places is usually fertile if an excess of alkali is not present, but the greatest care and judgment should be used in selecting a site in such soils. In regions where a hard stratum of subsoil appears there is danger of selecting a site where the soil is of so little depth that it will become waterlogged by the settling of the moisture into the low places in the hardpan. Or one may find a soil which does not provide sufficient depth for normal root growth for plum trees. When planted on fertile shallow soils underlain with hardpan, trees often grow well for a few years and produce fairly well while young, but an unprofitable crop of fruit or the loss of trees often follows by the time full production should have been reached.

Soils rich in nitrogen may cause a thrifty growth, but those well balanced in available plant foods are necessary for the regular and continued production of large sizes of well-developed fruit. While the size of the fruit for fresh shipment can be regulated to a considerable extent by the manipulation of irrigation water, fertile soils are necessary also for the proper growth and development of fruit. Excessive irrigation often causes a low sugar content in fruit, and planting on poor soil results in a crop of small fruit which will prove unprofitable, since within the variety prunes are classified almost entirely as to size when placed on the market.

CLIMATIC CONDITIONS.

The plum will thrive where winters are cold and will withstand hot summers, drought, and heavy rainfall as well as or perhaps better than other common deciduous fruits. Frequent and sometimes heavy losses are sustained in some localities, however, from injury to the blossoms by late spring frosts. Some varieties of the Japanese group in common cultivation blossom early in the spring, often several days or weeks before the last frost occurs, while the varieties of the domestica group, usually blooming considerably later, are seldom injured by frost. Practically all sections of the Pacific States where plums are grown commercially are visited occasionally by late frosts, although small areas of somewhat elevated rolling lands are considered to be free from any considerable loss from them. While the plum tree will withstand a heavy rainfall, rainy and foggy weather during blossoming time hinders pollination, and rains during harvest favor the growth of fungi, causing the fruit to decay

XUM

and therefore seriously hindering both fresh-fruit shipments and prune making. For both long-distance shipment of fresh fruit and for drying, which are the principal objects of plum growing in the Pacific States, the long, dry, hot summers which prevail are well suited.

TABLE 2.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States.*

[Data (in degrees F.) for representative plum and prune producing sections of each district, from the summaries of climatological data for the United States by sections for the different stations, as follows: *A*, section 14, central and southern California, p. 22-24; *B*, section 16, northwestern California, p. 16-17; *C*, section 15, northeastern California, p. 36-37; *D*, section 17, western Oregon, p. 18-19; *E*, section 19, western Washington, p. 9; *F*, section 20, eastern Washington, p. 10; *G*, section 22, southern Idaho, p. 5.]

CENTRAL CALIFORNIA COAST DISTRICT.

Stations.		Mar.	Apr.	May.	June.	July.	Aug.	Sept.
San Jose (*A*)	Maximum	63.8	69.9	72.3	76.9	80.9	79.9	79.3
	Minimum	43.7	44.4	45.8	48.7	52.0	51.2	50.0
	Mean	53.7	56.7	60.7	65.0	66.9	66.7	64.7
Hollister (*A*)	Maximum	64.4	69.2	71.5	77.2	81.2	79.8	79.1
	Minimum	40.6	41.5	43.8	46.8	48.7	49.2	47.5
	Mean	54.5	58.2	62.3	65.9	67.2	66.7	65.6
Napa (*B*)	Maximum	63.0	68.8	72.9	79.0	81.2	80.5	80.8
	Minimum	42.1	43.8	47.1	50.5	52.8	52.1	50.1
	Mean	52.6	56.8	60.8	65.4	67.6	67.0	66.0
Healdsburg (*B*)	Maximum	67.1	73.5	77.2	83.8	89.4	87.7	85.6
	Minimum	40.5	43.3	46.2	49.4	50.8	49.3	47.7
	Mean	52.1	56.9	59.9	65.9	68.5	66.5	65.7

INTERIOR VALLEYS OF CENTRAL CALIFORNIA.

Tulare (*C*)	Maximum	69.0	77.5	82.4	91.7	99.6	97.2	88.8
	Minimum	40.8	44.5	49.9	56.1	60.2	58.9	52.7
	Mean	55.9	62.6	68.2	77.4	83.0	80.1	71.9
Stockton (*C*)	Maximum	60.9	67.9	73.5	82.7	88.5	86.5	81.8
	Minimum	43.2	46.6	50.0	55.6	57.0	56.5	54.8
	Mean	54.5	58.9	64.1	69.9	72.6	72.5	69.0
Chico (*C*)	Maximum	66.3	73.0	79.9	89.3	98.9	97.4	88.7
	Minimum	41.2	44.8	49.0	55.0	60.2	58.3	53.5
	Mean	55.6	61.6	68.4	77.1	83.9	81.5	74.6
Auburn (*C*)	Maximum	62.5	69.0	74.7	85.1	91.7	91.8	83.5
	Minimum	42.0	44.7	50.1	55.0	61.1	60.3	54.4
	Mean	51.7	56.5	62.7	70.8	76.8	75.9	71.0
Vacaville (*C*)	Maximum	65.9	71.5	78.5	84.1	93.5	92.1	86.4
	Minimum	42.7	45.4	48.6	51.7	55.8	55.6	52.5
	Mean	53.9	58.8	64.2	71.0	75.5	74.5	70.8

WESTERN OREGON AND WESTERN WASHINGTON.

Roseburg, Oreg. (*D*)	Maximum	57.0	62.1	68.0	72.7	81.0	81.2	74.1
	Minimum	38.1	40.1	44.9	48.9	52.6	52.3	47.9
	Mean	47.6	51.4	56.5	60.8	66.9	66.7	61.1
Salem, Oreg. (*D*)	Maximum	55.1	60.9	66.3	72.0	79.6	80.1	72.0
	Minimum	37.9	41.0	45.5	49.7	53.3	53.1	48.7
	Mean	46.2	50.8	55.9	60.9	66.4	66.4	60.3
Vancouver, Wash. (*E*)	Maximum	55.9	62.5	66.8	72.7	79.7	79.5	72.8
	Minimum	37.1	39.7	45.3	49.7	53.2	52.3	47.9
	Mean	45.7	51.6	57.5	62.2	66.9	66.2	60.9

TABLE 2.—*Maximum, minimum, and mean temperatures, etc.*—Continued.

EASTERN WASHINGTON, EASTERN OREGON, AND IDAHO.

Stations.		Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Walla Walla, Wash. (*F*)...	Maximum	54.2	63.5	71.3	77.8	88.2	86.7	75.5
	Minimum	36.8	42.6	48.6	53.7	60.8	60.2	52.3
	Mean	45.5	53.0	59.9	65.8	74.5	73.5	63.9
Moxie, near Yakima, Wash. (*F*).	Maximum	56.5	66.5	74.0	80.9	88.9	87.4	77.3
	Minimum	28.5	34.3	42.0	48.0	53.1	51.1	42.4
	Mean	42.6	50.4	58.2	64.6	71.3	69.5	59.9
Boise, Idaho (*G*)..Mean		44.2	50.1	57.6	66.0	72.8	71.8	61.9

PALOUSE REGION, WASHINGTON.

Colfax, Wash. (*F*)...	Maximum	50.8	60.0	67.9	73.9	82.8	82.8	72.2
	Minimum	30.0	35.1	40.5	44.6	47.4	46.5	40.4
	Mean	40.4	47.6	54.2	59.3	65.1	64.9	56.3

SUMMARY OF AVERAGES BY DISTRICTS.

Maximum:							
Central California coast district	64.6	70.3	73.5	79.2	83.2	81.9	81.2
Interior valleys of central California	64.9	71.8	77.8	86.6	94.4	93.0	85.8
Western Oregon and western Washington	55.7	61.8	67.0	72.5	80.1	80.3	73.0
Yakima and Walla Walla, Wash	53.5	65.0	72.6	79.6	88.5	87.0	76.4
Minimum:							
Central California coast district	41.7	43.2	45.7	48.8	51.1	50.5	48.8
Interior valleys of central California	42.0	45.2	49.5	54.6	58.8	57.9	53.6
Western Oregon and western Washington	37.7	40.2	45.2	47.1	53.0	52.6	48.2
Yakima and Walla Walla, Wash	32.6	38.4	45.3	50.8	57.4	55.6	47.3
Mean:							
Central California coast district	53.2	57.1	60.9	60.5	67.5	66.7	65.5
Interior valleys of central California	54.3	59.6	65.5	73.2	78.3	76.9	71.6
Western Oregon and western Washington	46.5	51.2	56.6	61.3	66.7	66.4	60.4
Yakima and Walla Walla, Wash., and Boise, Idaho	43.4	51.2	58.6	65.5	72.5	71.2	61.9

In western Oregon and western Washington fall rains and high humidity at harvest time make it necessary to dry fruit artificially. Dry fall weather permits open-air drying, which is the prevailing method used in California, although with occasional damage to the fruit by rains. In the Palouse region of eastern Washington and western Idaho, where the prevailing temperatures are much lower than in other plum-growing centers of the Western States, the fruit develops slowly and usually is left on the trees until frost occurs in the fall, as it is claimed to be difficult to shake the fruit from the trees before that time. After one or two killing frosts it is shaken down easily.

Summer rainfall is exceedingly light throughout the fruit-growing sections of the Pacific Coast States, but the differences in temperature between the fruit-growing sections of these States is sufficient to cause wide differences in the practices followed in orchard management. For the most profitable production of early plums of Japanese and American-Japanese hybrid varieties, the fruit should be shipped before the later ripening varieties of the domestica group, which in the earliest plum-ripening sections of California is midsummer. This is possible only where the spring and summer are warm, as the later ripening varieties mature under such conditions before the earlier

XUM

ripening ones in cooler regions. For this reason the cultivation of early-ripening plums has been largely confined to the hot interior valleys of California.

The mean spring and summer temperatures of a plum section largely determine the type of plum growing carried on there. For example, fruit for fresh shipment is largely grown in the hot interior valleys, as compared with the cooler Santa Clara, Sonoma, and Napa Valleys in California, where fruit for drying into prunes is principally produced. In the cooler valleys of California the Agen prune is the principal one grown, while in the Northwestern States, where still lower mean temperatures prevail, the Italian prune, planted only sparingly in California, is grown almost exclusively. However, in a few places in the warmer sections of these States the Agen and other varieties of the domestica group are cultivated to a considerable extent. Temperatures of the principal plum-growing sections are given in Table 2, compiled from the records of the Weather Bureau.[1]

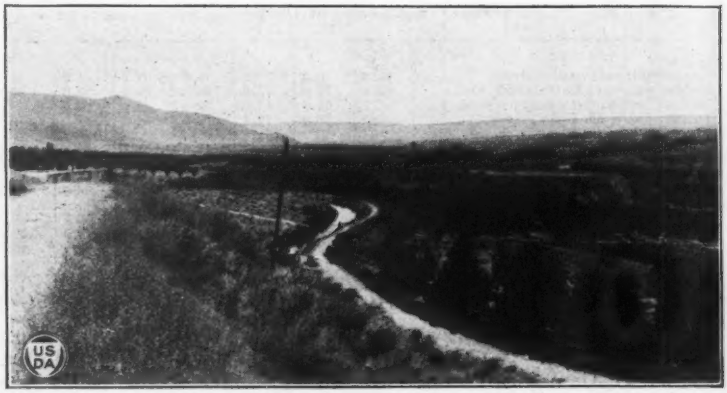

FIG. 8.—Sites on a slope where soil and air drainage are better for orchards than in the lower portion of the valley in the distance. (Emmett, Idaho, August, 1921.)

SITE AND LOCATION.

In choosing a site and location for plum growing careful consideration should be given to spring frosts, soil drainage, transportation facilities, and also to irrigation in sections where it is necessary.

If spring frosts are common, rolling or sloping land should be chosen, avoiding the low, flat plains, depressions, and troughs of ravines through which the cold air, like water, flows to lower levels. Even slight differences in elevation often prove of great importance in this respect. (Fig. 8.)

The growth of plum trees on fertile soil washed down through ravines encourages the orchardist to continue plum planting there, but in such locations the planting of fruits which blossom later in

[1] U. S. Department of Agriculture, Weather Bureau, Climatological Division. Summaries of climatological data sections. U. S. Dept. Agr., Weather Bur. Bul. W, vol. 1. 1912.

——— Summary of the climatological data for the United States, by sections. U. S. Dept. Agr., Weather Bur. Reprint [Revision of Bul. W] Sect. 14–17, 19–20. [1912–1918.]

the spring would usually result in less loss from frost and no doubt prove more profitable. Orchards occupying the rolling areas bordering the larger fruit-growing valleys, while more difficult to cultivate, are decidedly more nearly free from frost injury to the blossoms than those on the low flat valleys or the high flat tablelands.

Where the soil near lakes of considerable size or ocean bays is suited to cultivation, only little, if any, loss from spring frosts need be feared. In the consideration of sites such places are preferable because the water will temper the hot days of summer as well as protect from the cold in spring. The effect of such a body of water is well illustrated near the border of Lake Vancouver, not far from the city of Vancouver, Wash., where prune production is an important industry and where it is claimed that severe injury to the crop by frosts is unknown. The opposite result in regard to frost naturally obtains along smaller rivers, as here the heavy cold air settles in and follows the course of the water.

FIG. 9.—Prune trees, dead as a result of poor drainage; the fate of trees on low, heavy soil.

Soils which are low, heavy, and in danger of becoming waterlogged during wet seasons or in which surplus water from irrigation collects should also be avoided. While the plum is not so sensitive to an excess of soil water as some fruits, small crops and weak trees and often loss of trees follow planting in such places. (Fig. 9.) Only well-drained soils should be selected.

The unquestionable advantage of facilities for irrigation in the regions where irrigation is practiced prove the need of choosing lands where a system is already established or where a water supply sufficient for the type of soil under consideration can be made available. Both prunes and plums are sold largely by their size, and as the soil moisture determines to a great extent the sizes of the fruit the water supply should not be overlooked.

The condition of country roads and the proximity of packing houses and shipping stations need also to be taken into account. While these are not so important where the fruit is to be dried, good smooth roads, preferably free from dust and with packing and shipping facilities close by, are decided advantages to the shipper of fresh plums who must send his product to distant markets.

XUM

VARIETIES.

The ease with which new strains and varieties may be created by artificial crossing or by the selection of chance seedlings and the patience and intelligence exercised by many western plum growers in testing new types has led to the development of a large and ever-increasing number of varieties. Many of these varieties have been taken into almost every locality where orcharding is not entirely prohibited by natural conditions, and the requirements of varieties with respect to soil, weather peculiarities, and cultural conditions, both natural and artificial, have been determined perhaps more closely than for any other of our cultivated fruits.

Many of the commercial varieties of plums widely planted in the Pacific States were originated or first introduced into cultivation there, and in most instances in central California. Many new varieties of promise are now being introduced to the trade.

In establishing an orchard for the production of plums for the fresh-fruit market, it is the practice to plant a number of varieties which ripen in succession, so that the fruit pickers may go from one variety to another without interruption, thus avoiding the necessity of procuring additional help to harvest the varying number that ripen at the same time. Where there is a period of a few days between the ripening of varieties in the succession, or if a variety fails to fruit, considerable confusion and perhaps financial loss results from the disorganization of the picking, packing, and hauling crews. This emphasizes the importance of selecting varieties for their regular bearing habits as well as for quality and appearance of fruit and those so suited to the peculiar soil and climatic conditions that they fit into the successive ripening scheme.

Many varieties are partially or entirely self-sterile. When such varieties are planted, other sorts which will pollinize them must also be planted near by. At the same time these pollinizers must possess desirable qualities for commercial planting and likewise fit into the list for successive ripening. With the great number of plum varieties, each with its peculiarities as to growth, production, quality of fruit, and the broad demands of the grower and the market, the choice for planting becomes one of greatest importance to growers. For prune making the conditions to be met are not so numerous as in the production of fruit for fresh shipment. The selection of a variety adapted to the natural local conditions, including soil and climate, is the principal problem. Shortage of labor and the loss of a little time in harvesting, processing, or delivering to local or distant markets cause no such loss or concern to the grower who dries his fruit as to the one who must harvest, pack, and deliver his fruit to the consumer within a relatively short time or else withstand a severe or perhaps total loss of his fruit by spoiling or having his product offered on a market when the price is unsatisfactory.

The expense of picking and packing the fruit, the purchase of shipping containers, and the cost of icing and transportation to the distant market is relatively considerably higher for the fresh fruit than for the dried product. Owing to these expenses the hazards in the production of fresh fruit are considered by many to be greater than for prunes, although the high market price for fresh fruit makes its culture desirable if natural conditions are favorable to the

development of large fruit of good quality. A large number of varieties are under cultivation for the production of both fresh and dried fruit, although the diversity required for the profitable growing of fresh shipping plums has led to the planting of a much greater number of varieties for this purpose than for prune production.

The dates of blooming as well as of ripening of a variety may vary from a few days to three or four weeks from year to year with the different varieties, depending on climatic conditions. Slight fluctuations sometimes occur in the relative ripening dates of varieties, although within a given orchard these differences are small and beyond the power of the orchardist to regulate to financial advantage. At different elevations and under other varying conditions both blossoming and ripening dates of a variety may differ considerably even in adjoining orchards. The conditions that prevail in low, wet, heavy lands and at high elevations tend to cause late blossoming and ripening of the fruit, while those that characterize the well-drained soils of low, rolling land, especially those of southern and eastern exposure, favor relatively early blossoming and ripening.

Considering the principal plum sections in California, in which are grown more or less extensively nearly all varieties of plums produced commercially in the Pacific States except the Italian prune, harvesting starts during the latter part of May in the foothill section near Vacaville, in Sonoma County. In the Vaca Valley, which borders these foothills, the earliest harvests are about one week later and almost simultaneous with the foothill section of Placer County and a few days in advance of the main portion of the Sacramento and San Joaquin Valleys.

The principal variety grown for fresh shipment in the other States included in this discussion—Oregon, Washington, and Idaho—is the Italian prune. Other varieties grown commercially in these States include Tragedy and Pond, with less important plantings of California Blue, Diamond, and a few others. The ripening dates of these varieties are three or four weeks later than in the plum-producing sections of California.

A few important qualities of the most prominent commercial varieties grown on the Pacific coast are here described to guide the orchardist in his choice for future planting. These varieties represent three groups or classes of plums: (1) The Japanese sorts, those derived from the oriental form known to botanists as *Prunus salicina*, including many varieties grown for their fresh fruit; (2) those derived from the European form (*Prunus domestica*), which includes the so-called "European," domestica," "purple," or "blue" plums and to which belong the varieties grown for prunes as well as many for shipping fresh; (3) hybrid sorts originated by crossing Japanese with native plums, grown for use in the fresh state.

VARIETIES OF PLUMS AND PRUNES IN THE PACIFIC STATES.

VARIETIES OF THE PRUNUS TRIFLORA (SALICINA) GROUP AND ITS DERIVATIVES OR HYBRIDS.

[The asterisk denotes that the variety was originated and introduced into cultivation in central California.]

BEAUTY.*—This is the earliest ripening of the commercially grown varieties and is therefore a favorite in sections where fruit is produced for the early market. Cross-pollination is not essential. The tree is thrifty and inclined

to bear well and regularly; thinning the fruit is often found necessary. The fruit is medium in size, often with considerable variation on the same tree. It is very attractive and carries to the market well.

BURBANK.—This is one of the principal varieties of the Japanese group grown on the Pacific coast. Its harvest comes after the Climax and Maynard and just before the Santa Rosa. The fruit is medium in size and quality and carries to market exceedingly well. The Burbank is a regular and prolific bearer, and unless thinned the fruit is often undersized. The blossoms are self-sterile, but appear with those of many other varieties which, if near by, are usually sufficient to pollinize it. The ripening season is rather long. The tree is thrifty, spreading in habit of growth, and suited to a wide range of climatic conditions. This variety is planted for its regular and heavy crop of fruit, but it ripens in the middle of the plum-shipping season, and low prices are sometimes received for it.

CLIMAX.*—Fruit large and attractive, but ripens rapidly, is rather soft when ripe, and therefore requires considerable care in harvesting and must be hurried to market. The blossoms are self-fertile, and regular crops of fruit are therefore expected.

DUARTE.—Fruit very large, of good shipping quality, and has attractive dark-red flesh. This is the earliest to ripen of the so-called "blood" plums, but one of the latest of the Japanese type of varieties grown for fresh-fruit shipment. Its blossoms are self-sterile, but appear late, and good crops are expected where the trees are planted near other varieties of the same group. This is one of the most recent introductions and is as yet only sparingly planted.

FORMOSA.*—While among the earliest ripening varieties, its fruit is very large. It is one of the most attractive of commercial plums, of excellent eating quality, and carries to distant markets exceedingly well. The blossoms open early in the spring and therefore are in danger of being injured by frosts. The tree is thrifty and grows to a large size. The blossoms are self-sterile, and on account of difficulties in pollination the yield has been very low in all but an occasional orchard. As a result, many orchards of it have been top-grafted to other varieties. Good crops have been harvested where trees are growing near the Wickson, the Santa Rosa, and some other varieties of the Japanese type and when there is an abundance of bees. The yield of this variety is usually the best when it is top-grafted on old trees.

GAVIOTA.*—Fruit very large, attractive, of good eating quality, fair in texture, and keeps and ships exceedingly well. The blossoms appear rather late, and the fruit ripens among the latest of the varieties of this type and a little after midseason for fresh-plum shipments. On account of its firm flesh the fruit may be harvested over a long season and if picked when well ripened will still reach the market in good condition. The trees are vigorous, prolific, and inclined to be regular in bearing if the blossoms are pollinized. Its blossoms are self-sterile, and the trees should therefore be planted near other varieties of the same group which blossom at the same time.

KELSEY.—Fruit large, of good eating quality, attractive when well colored, keeps and ships well, has a rather long ripening season, and is one of the latest of the more extensively grown Japanese varieties. The fruit colors well in sections where cool summer breezes prevail, but poorly in the hot interior valleys of California where fruit for fresh shipment is grown extensively. Its blossoms are self-sterile, but it usually bears well when planted with closely related varieties. Although widely distributed, the Kelsey has been planted only sparingly during late years, owing largely to the poor coloring of the fruit in sections where plums for fresh shipment are most extensively grown.

SANTA ROSA.*—This variety is harvested somewhat before midseason, and the ripening season is longer than for many varieties of Japanese plums. The fruit is large and very attractive, purplish crimson in color, having dark-red flesh of fine eating quality, and carries well to market. It blooms early, and the blossoms are sometimes injured by frost. It is benefited by cross-pollination and on account of late frosts and faulty pollination is inclined to be irregular in bearing. The Wickson and Beauty varieties, blossoming about the same time as the Santa Rosa, have been recommended for planting near it for pollinizers. The tree is a vigorous, compact, upright grower and should be pruned to induce a moderate new growth and an open framework. Severe cutting back of the tops causes a long, erect growth of new wood which forms a compact top, thus heavily shading the branches and spurs of the old wood.

SATSUMA.*—Fruit of good size, dull red in color, and purplish red flesh. It is of good flavor, high in dessert quality, and favored for culinary purposes but not for shipping fresh, although a small acreage is grown for this purpose. The tree is vigorous, but inclined to bear light crops until it reaches several years of age.

WICKSON.*—Fruit very large, attractive, good in flavor and dessert quality, and carries to market well. It is one of the earliest varieties to blossom in the spring, and late frosts often shorten the crop. It requires cross-pollination. As it blossoms with but few other varieties, light crops sometimes result from lack of other pollen. It is planted more extensively along the Pacific coast, probably, than any other variety of the Japanese group.

VARIETIES OF THE PRUNUS DOMESTICA GROUP.

AGEN (*French prune or Petite prune*).—The fruit of this variety is perhaps the smallest of any of those used for prunes. It is dull reddish purple in color, very rich and sweet in flavor, and has a rather tough skin. As the sugar content is high it dries quickly and easily. The tree is thrifty, a moderately vigorous grower, and regular and prolific in its bearing habits. It blossoms in midseason for the prune varieties and ripens its fruit late. The fruit clings to the tree until after drying starts, which insures against injuries during harvest, thereby shortening the period which would otherwise be required for it on the drying trays. The planting of this variety exceeds by many times the combined area of all other varieties grown for prunes in California, and it is of commercial importance in western Oregon and western Washington. Its blossoms are self-fertile, and it may therefore be planted in solid blocks, although interplanting with the Sugar and Imperial Epineuse varieties has been recommended as a benefit to fruit setting. It requires a deep fertile soil for the production of good crops of large fruit. Adverse local conditions or overheavy crops result in small fruit. An abundant supply of small fruit, with prices on a size basis, is the chief hindrance to a satisfactory market price for this variety.

CALIFORNIA BLUE.*—Fruit ripens in midseason, is medium to large in size, round, bluish in color, of only fair dessert quality and flavor, and carries to market well. Its ripening period is rather short. The tree is very prolific, but it bears only in alternate years, at least in some localities. Its blossoms are self-fertile. The tree is inclined to branch but little, is spreading and open in habit, and produces fruit on wood of all ages, making the harvest easy. As yet its culture has been confined mostly to a few sections in central California near which it was originated, although it is giving encouraging results in central Washington orchards.

CLYMAN.—Ripens earliest among the domestica group of plums on the Pacific coast and follows closely the earliest of the Japanese group. It is dark blue in color, of medium size, fair in eating quality, and carries well in shipment. The blossoms are self-sterile, open early, and the trees should therefore be interplanted with other early-blossoming varieties. The Tragedy variety has been suggested as a pollinizer.[2] Clyman is not a dependable producer in most sections, probably on account of lack of pollination and injury by frost. The tree is a vigorous grower and favored as a stock for top grafting.

DIAMOND.*—Fruit large, handsome, rather sour, and second rate in eating quality, but its tartness has made it a favorite during late years in eastern markets. It is firm in texture and carries well to distant markets. Its fruit ripens a little after midseason and is the first purple plum of commercial importance to ripen after Tragedy. The wood of this variety makes probably the poorest union with the peach stock of any of our commonly cultivated plum varieties.

GOLDEN DROP.—Known as "Silver prune" on the Pacific coast. Fruit large, of good dessert quality, and keeps and ships well. On account of its golden yellow color it is suited for canning, but not popular for shipping fresh. It is one of the later ripening varieties used for canning, but is not so popular now as in past years.

GIANT.*—Fruit medium to large in size, attractive in appearance, but lacking in flavor and juiciness. Owing to its rather dry flesh it carries to market exceedingly well. Its blossoming season is late, and the fruit ripens among the

[2] Hendrickson, A. H. Plum pollination. Calif. Agr. Exp. Sta. Bul. 310, p. 18. 1919.

late varieties commonly grown for their fresh fruit. The fruit is about midway in size between that of its parents, the Agen and Pond. Like the former the tree is vigorous, its blossoms are self-fertile, and it fruits heavily from year to year. It resembles the Pond in that the fruit is somewhat lacking in flavor and juiciness and is rather coarse.

GRAND DUKE.—A plum which has been widely tested in plum-growing centers of the Pacific States and is extensively planted in California. Its fruit is large, attractive, firm, not very juicy, has a high sugar content, keeps and ships well, but is second rate in dessert quality. The blossoms appear late and require cross-pollination. The fruit ripens with that of the latest of the varieties of this group which are cultivated for their fresh fruit, and like those varieties the ripening season extends over a comparatively long period.

IMPERIAL EPINEUSE.—Fruit large when compared with that of other varieties grown for shipping fresh and larger when dried than that of other varieties commonly used for prune making. It is dark red, juicy, of good quality and appearance, and excellent in eating quality. Owing to the high prices paid for the dried fruit, the larger portion of the crop of this variety is made into prunes. The tree is vigorous, but inclined to be a shy bearer in most localities, this being due, probably, to the lack of cross-pollination. The Agen and Sugar varieties have been recommended for interplanting with the Imperial Epineuse as pollinizers. The tree requires a deep, fertile soil for satisfactory growth. This requirement, together with its irregular cropping tendencies, has prevented it from being extensively planted in some plum centers. It is at present grown to a limited extent in many places and in the Sonoma Valley is one of the most favored varieties.

ITALIAN PRUNE.—Fruit medium to large, dark purple in color, of a pleasing tart flavor, and firm in texture, making it first class both for fresh shipment and for drying. It is grown extensively for both these purposes in Oregon, Washington, and Idaho, where it is by far the most important variety under cultivation and one which is still the most extensively planted. The blossoms are self-fertile, and therefore it may be planted in large blocks without other varieties. It is adapted to a wide range of temperature, but requires a deep, fertile soil.

JEFFERSON.—Fruit similar to Golden Drop and used for canning, as is that variety; it is one of the most popular varieties for that purpose. Although a fruit of good eating quality and flavor it is not favored for fresh shipment on account of its color.

PRESIDENT.*—Fruit medium to large in size, very dark purple in color, of very good eating quality and texture, ripens among the latest of the purple domestica plums, and carries to the market well. The tree is thrifty and inclined to bear regular and heavy crops. It has been grown commercially for but a few years and is not yet widely cultivated. It is recommended for planting by those who wish to grow late-ripening plums for the fresh market.

POND.—Called "Hungarian prune" on the Pacific coast. Its fruit is the largest of the commercially cultivated varieties of this group, very attractive, and purplish red in color. Its flesh is firm and lacking in juiciness, making it well suited for shipping. In eating quality it is only second or third rate. There is a tendency for the fruit to form doubles, one side often imperfect in shape. Such fruits are not favored in the markets and are difficult to pack. Its blossoming season is intermediate with other plums and its fruit-ripening season is late. The branches make a slender upright growth and are inclined to send out too few fruiting twigs and branches. The tree should be pruned to induce a moderate wood growth and branching. In the interior valleys of California, where the summers are hot, the tree is lacking in vigor. There is often a poor wood and leaf growth and considerable sunburning of wood and fruit. In States farther north, where the summer temperatures are lower, the tree is thrifty and productive, with decidedly less injury from sunburning.

QUACKENBOSS.—Produces large, beautiful, purple fruit of good eating quality and sufficiently firm to carry to market well. It ripens among the late blue plums. Its blossoms appear rather late and therefore usually escape injury by frosts, but they are self-sterile, and poor crops often result from this cause. The trees are vigorous and make a more satisfactory union with the peach root than most other varieties of this group.

REINE CLAUDE.—Considered one of the best varieties for canning, being among the foremost sorts grown for this purpose. It is not important as a variety for fresh-fruit shipment.

SERGEANT (*Robe de Sergeant*).—Fruit somewhat below the medium size of varieties of this group grown for their fresh fruit. When dried it is about medium size among the prunes. Its dark-purple color, becoming almost black when the fruit is ripe, and its rich pleasant flavor make it well suited for prunes. The tree is thrifty but often fails to bear satisfactory crops, especially in the cooler sections. It is considered profitable only on deep fertile soil, as elsewhere the fruit is too small. This variety has been grown to a considerable extent in California, although new plantings of it are rare both there and in the States farther north.

STANDARD.*—Thought to be a cross between the Sugar and Tragedy varieties. Fruit large, dark purple in color, freestone, and sweet, but otherwise medium in eating quality. The tree is inclined to be very irregular in bearing habits. The variety is of minor commercial importance at present, and in most places its planting has been discontinued.

SUGAR.*—Fruit medium in size when compared with other varieties grown for fresh shipment, although considerably larger than its parent, the Agen. It is dark purplish red in color, juicy, and has a rather tender skin. It is sweet, but otherwise second rate in dessert quality. The blossoms appear late, making them comparatively free from danger of frost injury. Being also self-fertile good crops are usually insured. The trees of this variety are inclined to be prolific. If the fruit is not thinned, small sizes usually result, and an excessive crop is often followed by a light one or a failure the following year. The tree is open and spreading and the wood very brittle and inclined to become stunted where little pruning is done. Good soil and cultural conditions are required for a satisfactory tree growth. When the market price for plums is low, the fruit is dried into prunes, although considered only second class for this purpose. While less popular at present than in past years, it is still found in practically all centers of plum production in the Pacific States. A few new plantings of it are being made.

TRAGEDY.*—One of the earliest and best of the domestica plums for fresh shipment, both as to eating quality and for profitable returns. It is a favorite variety for planting in those sections of central California from which fresh plums are shipped, and it is grown to some extent in parts of eastern Washington. Its fruit is medium in size for a domestica, attractive in appearance, and ships well. The blossoms are self-sterile, and poor crops often result from this cause. The Clyman has been recommended as a pollinizer.

YELLOW EGG.—Fruit large, only fair in eating quality, and rather soft when ripe, making it inferior in this respect for fresh shipment. Its golden yellow color makes it suitable for canning but not for selling fresh. For canning it is one of the most favored varieties, but the increasing demand for plums for shipping has resulted in the top-grafting of orchards of this to other varieties. The trees are vigorous and inclined to bear regular and heavy crops.

POLLINATION.

Among the foremost of the considerations to be given to the planting of plum orchards is that of pollination. This is more especially true with varieties for fresh-fruit shipment, for many common varieties grown for this purpose are entirely sterile with their own pollen, or the crop may be greatly increased by cross-pollination. To the lack of pollination many light crops or entire failures may be attributed. In some instances the planting of a variety has been discontinued on account of poor crops from this cause.

The most practical means for providing cross-pollination in commercial orchards is to interplant varieties which may be fitted into the scheme of a ripening succession to extend the fruit harvest. In the interplanting of varieties it may be convenient to plant the succession so as to accommodate fruit-picking crews, but this should be done in every case to favor pollination. Only a few rows of a variety known to be entirely or to a large degree self-sterile should be planted together. Solid blocks should never be planted, as with

XUM

self-fertile varieties. For convenience in fruit harvesting, from two to four rows of a variety are usually planted together.

In the selection of a pollinizer, provided more than one variety will cross readily with the one to be pollinized, a variety which blossoms with it, having a long blossoming period and regular in blooming habits, should be chosen rather than one which tends to blossom in alternate years.

As a group the Japanese varieties and those derived from them are considered to require cross-pollination or to be greatly benefited by it, with the exception of the Climax, which is self-fertile. Among the domestica varieties (the only other group represented in commercial plum planting in the Pacific States), the Tragedy, which is probably the most important of the group grown for the fresh fruit, is self-sterile, as are also the Imperial Epineuse and other less important varieties. Several of them, including two important varieties for prune production—the Agen and Italian prune—are self-fertile.[3]

While varietal tendencies regarding pollination are very decided, the percentage of blossoms to set fruit, irrespective of weather conditions, varies with the age and thrift of the tree. Where top-grafted on older trees, especially if the stock and scion are somewhat uncongenial and produce an imperfect union, a heavier set of fruit sometimes results than from normal trees. Heavy crops under these conditions have been noted in the case of the Formosa variety. This is a self-sterile sort and notorious for its small crops and failures even when planted in orchards containing many other varieties. Eight-year-old grafts of the Formosa in old apricot trees adjoining Santa Rosa trees have been observed to bear excellent crops, while 8-year-old Formosa trees started in a nursery and planted the same distance from the Santa Rosa trees as were those produced by top-working bore practically no fruit.

The presence of bees in the plum orchard at blossoming time has been demonstrated to be almost an economic necessity. (Fig. 10.) Poor crops or perhaps failures may be expected of self-sterile varieties where no bees are present, and even with self-fertile varieties the presence of bees has caused a decided increase in the crop.[4]

Cold, foggy, or rainy weather at blossoming time is very detrimental to the setting of fruit. A careful selection of varieties must be made for planting in places where such weather is common during the spring, and commercial plantings should be confined to varieties which have proved themselves suitable to the local conditions.

STOCKS USED IN PROPAGATING PLUM TREES.

Only a small portion of the plum trees for commercial planting are propagated in the home nursery, professional nurserymen being depended on to supply trees with stocks suited to the orchard conditions. In his selection of stocks the nurseryman is guided by the demand of orchardists for trees propagated on one stock or another and by his own interest in producing cheaply propagated trees which make a rapid growth.

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[3] For results in cross-pollination with the common varieties of plums, see Hendrickson, A. H., Plum pollination. Calif. Agr. Exp. Sta. Bul. 310, p. 1–28, 5 fig. 1919.

[4] Hendrickson, A. H. The common honeybee as an agent in plum pollination. Calif. Agr. Exp. Sta. Bul. 274, p. 125–132, 2 fig. 1916.

For propagating plum trees the myrobalan plum and the peach are by far the most important, although the almond is used in some localities, at least in California. An occasional orchard may also be found where the Marianna plum and the apricot are used for stocks. Each of the first three stocks mentioned is suited to different soil conditions, and the myrobalan plum and the peach are suited to the soils generally chosen for plum planting. The myrobalan plum is preferred for deep, heavy fertile soils, especially if the rainfall is heavy or the orchard is under irrigation. It is not a rampant grower, but is a vigorous, long-lived, hardy, and deep-rooted tree, the roots withstanding a higher soil-moisture content than other kinds of roots. The myrobalan plum, however, prefers a deep, fertile, heavy, well-drained loam and is therefore at home in soils favored for prune production and is in most general use in that industry. It is also the one most commonly used for planting in the

FIG. 10.—Bee stands in a plum orchard. Cross-pollination in plum and prune orchards by bees has been proved of so much importance that many of the growers in California place stands in their orchards, at least during the blossoming period.

deep, fertile bottom lands, where plums are grown for the fresh-fruit market and for canning.

The peach root, while less resistant to excessive soil moisture than the myrobalan plum, will thrive better than the latter or other stocks mentioned in poor, shallow, or light soils, because its roots do not go so deeply into the earth, but make a vigorous spreading growth. A good moisture content and a soil of good tilth are, of course, required for the best root growth of the peach. It starts growth early in the spring, grows rapidly, succeeds in a wide range of soils, and is generally considered the most satisfactory stock for early-ripening plum varieties, at least in the shallower soils, where these varieties are extensively grown. It is used to a considerable extent for varieties for prune making where the soil is not sufficiently deep or the moisture content is below that required for the best development of the myrobalan roots.

The almond, one of the stocks used in California, is a thrifty long-lived tree, growing best in deep fertile well-drained soil and is the most drought resistant of the stocks commonly used. It does not

withstand excessive soil moisture as well as the peach or the myrobalan plum, but succeeds in places where it is too dry for those stocks. The plum tree is generally considered to grow less rapidly on the almond root than on the others commonly used and is propagated less extensively on it than on the others. The almond is used to a considerable extent as a stock for prunes in deep fertile soils not under irrigation. Large old prune trees which have excellent records of fruit production are found growing on this stock.

The Marianna plum is employed as a stock for plums in California, but it is more sensitive to drought and to excessive soil moisture than the other stocks, suckers badly, and is generally little used. It grows quickly and well from cuttings, which insures cheap and uniform stocks.

In the Northwestern States the myrobalan plum has been used almost exclusively as a stock since plum growing became an impor-

FIG. 11.—Old apricot trees top-grafted to plums. The trees on the left have just been grafted; the scions will start into growth as the trees renew their activities in the spring. On the trees at the right the grafting was done five years before. (Vacaville, Calif.)

tant industry there; but in California, where fruit growing is a more diversified industry and the growing of plums for fresh shipment is a comparatively new and rapidly increasing enterprise and the demand for different fruits has fluctuated considerably, the stock which is at present considered best for planting under a given condition is not the one found in the orchard in a great number of instances. Much superficial testing of different stocks has been in progress, and the changing popularity of varieties has caused many orchards to be top-grafted to other fruits or varieties, although the tree which then becomes the stock is not in all cases the one on which the new variety should be grown.

TOP-WORKING.

The principal reasons for top-working in the commercial orchard are the changing demands of the market in regard to the variety and quality of fruit and the desire to bring the trees quickly into

production. (Fig. 11.) As there has been an ever-changing demand in plum varieties, especially those for fresh-fruit shipment, much top-working of trees has been done in sections of central California where the growing of plums for fresh shipment is an important industry. In these sections top-grafting has been practiced since commercial plum growing was first established, and it is still a common procedure. It has proved to be a satisfactory method for changing the production of an orchard from one variety of plums to another, for the replacing of certain other fruits with plums, and for testing new varieties by bringing them quickly into bearing. (Fig. 12.) Only a few years are required for the new top to come to commercial production where conditions for fruit growing are good and where varieties inclined to be prolific are used. A crop of 1 to 2 crates of plums per tree has been harvested the second season after top-grafting, thus causing an interruption of only one year without a marketable crop in changing trees from one variety to another.

FIG. 12.—An orchard of top-grafted plum trees at Vacaville, Calif., June 4, 1921. These trees were originally the Kelsey plum. They were top-grafted eight years before to the Beauty plum.

This, however, is a more rapid change than would usually be expected. The top-grafting of peach and apricot trees to plums has been practiced to a large extent in this region during late years, owing to the increasing popularity of the plum as compared to the other fruits.

The operation of top-grafting is easily performed, and success may be expected if the trees selected are vigorous. The work of top-grafting is usually done in winter and spring after the pruning has been finished. In performing this work only strong well-spaced and well-shaped branches should be selected. These should be carefully sawed off at the desired height and the scions inserted by either the cleft or bark grafting method. As large wounds heal slowly, making the entrance of wood-rot fungi probable, small branches are preferred to large ones. If a limb 2½ or 3 inches in diameter or a little larger must be selected, at least three scions should be inserted, while for the smaller branches two are sufficient.

XUM

Instead of top-working by grafting, budding into small branches which grow from cut-back limbs is sometimes practiced for changing the tree from one fruit to another.[5]

In top-grafting, the unfortunate use of scions of varieties which do not form strong unions with the stock has resulted in the loss or poor growth of many trees. While the varieties of Japanese plums most commonly grown are inclined to be congenial with the peach stock, a number of varieties of the domestica group are not. (Fig. 13.) The Diamond and Grand Duke varieties when grafted on peach make perhaps the poorest unions among the varieties of this group in the region under observation, although the tree may continue to bear profitable crops over a considerable term of years after

FIG. 13.—Poor graft unions resulting from top-working old peach trees with the Grand Duke plum. The plum grafts are 12 years old. Note the enlargement of the lower portion of the grafts and injury from sunburn below. (Vacaville, Calif., January, 1920.)

grafting. When a variety is top-grafted to an uncongenial stock it will often appear undernourished, owing to the inability of the plant food to pass readily into the tissue below the graft union. The poor growth of foliage resulting from this condition causes poor protection from the sun; the old branches of the stock sunburn easily and are therefore more easily broken by the wind than where good unions are formed with the scion. (Figs. 14 and 15.) Whether all varieties of peaches would be equally desirable when used as stocks for top-working has not been determined.

[5] Hendrickson, A. H. Prune growing in California. Calif. Agr. Exp. Sta. Bul. 328, 38 p., 12 fig. 1921.

The plum on the apricot or almond sometimes gives unsatisfactory results in top-grafting, while good unions are expected in grafting one variety of plum with another. Trees known to form poor unions with the variety the orchardist wishes to grow are sometimes top-grafted with a variety known to unite well with both, and the next year these grafts are worked to the variety chosen for fruit production. (Figs. 16 and 17.) "Double working," as this practice is commonly termed, may be used in some instances to decided advantage if the trees to be top-grafted are large and well shaped and the grower does not wish to remove them.

To secure an open growth for a variety naturally compact and upright growing, the variety is top-grafted on one that is naturally

FIG. 14.—A poor union of the Grand Duke plum on a peach tree, resulting in poor growth, sunburning of the limbs, and subsequent decay and weakening of the branches. Such branches are easily broken by winds.

open and spreading. This is done after the spreading tree is 2 or 3 years old and has its framework branches established. (Fig. 18.)

That there may be a strain or some other obscure factor involved in the congeniality of stock and scion is suggested in Figures 19 and 20, which show the Agen prune top-worked on almond trees. In one case faulty unions have developed; in the other, congeniality appears to exist. Other similar instances are matters of observation.

Prior to actual trial there is apparently no means of determining what plum or prune varieties will show congeniality with particular stocks. For example, the Agen (*French prune*) has given excellent results when top-worked on apricot, though the plum wood at the point of union may grow somewhat larger than the apricot wood. The Agen propagated in the nursery on almond stocks makes a good growth, and the trees are long lived and vigorous. On the

XUM

other hand, in the case of the Imperial Epineuse plum, after growing for nearly 25 years the limbs top-grafted on a myrobalan plum tree began to indicate weakness at the points of union.

It does not necessarily follow that a variety propagated in the nursery on a particular stock and grown successfully in the orchard will give the same successful results if top-worked into a mature tree of the same species as the seedling nursery stock.

The work of top-grafting is not difficult or complicated. With moderate skill and a little practice one may expect a large percentage of his scions to grow. As the new top grows, all rough portions of the stubs in which the scions were placed should be carefully removed with a saw and chisel to insure the healing of the stump as quickly as possible. Where tree tops are removed for grafting, the stumps not needed should be carefully removed and the others protected from the sun with whitewash, especially if the trees are young and their branches are not protected by thick bark. The growth of young branches to furnish shade should be encouraged also. Carelessness in grafting and neglect of the old stumps and branches in succeeding years, both through failure to remove dead stumps of branches or portions of them which the new scion can not overgrow, has often resulted in sun scald, followed by the entrance of wood-decaying organisms and the ultimate loss of the tree. Such losses usually follow several years of unsatisfactory crops of fruit, and are by far the most severe on top-grafted trees where stock and scion are somewhat lacking in affinity. (Fig. 21.) Wood-decaying organisms, entering through grafting wounds or sunburn following grafting, are a very common cause of loss of top-grafted trees and necessitate the removal of a large number of trees annually. Often the removal of the entire orchard is necessary, owing to the poor stand of thrifty trees remaining after the removal of dead or unprofitable ones.

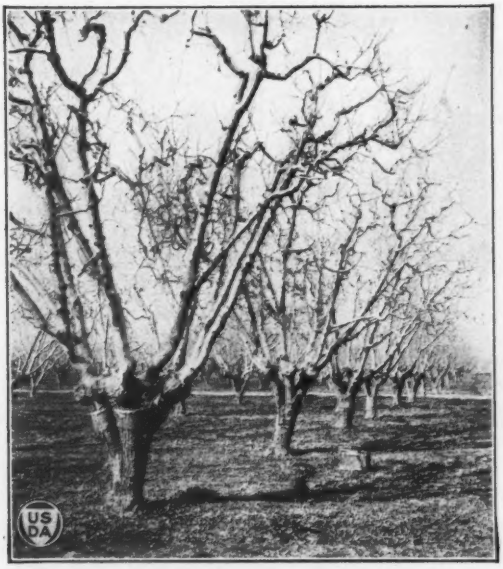

FIG. 15.—A row of peach trees which were top-worked to the Diamond plum. The enlargements at the points of union between the peach and plum wood indicate a lack of congeniality, although a fairly strong growth has been made by the plum top. The plum tops are about 20 years old.

DISTANCE FOR PLANTING.

From 18 to 24 feet has been the range commonly used for spacing plum trees in the orchard, 20 feet each way being the most common

FIG. 16.—Top of a seedling plum tree (in the foreground) two years after being double worked on apricot. A short section of Pond (*Hungarian prune*) is between the base of the plum limbs and the apricot. The tree therefore shows an apricot base top-worked to the prune, which in turn was grafted over to a seedling variety of plum.

distance. Where soils are fertile but the trees of the varieties planted are naturally small or upright in habit of growth or conditions are not generally suited to the production of large trees, the shorter dis-

tances are usually preferred. They are also sometimes preferred where a method of pruning is used to maintain low compact heads, provided water for irrigation is available so that the trees can not

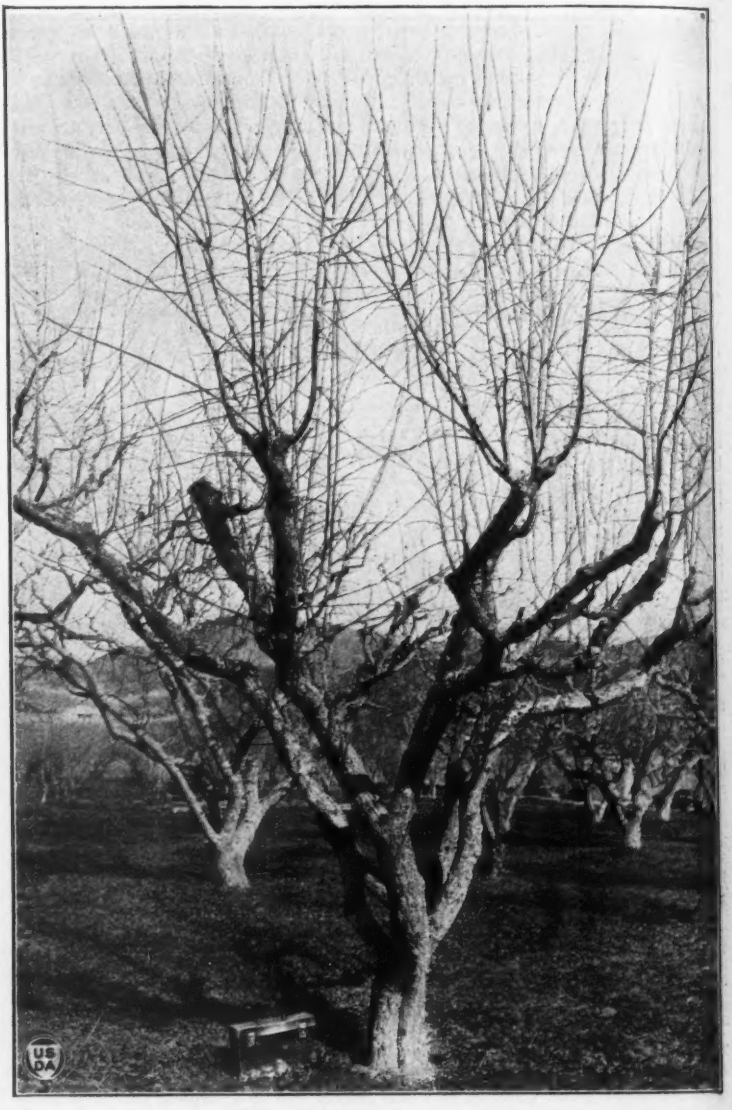

FIG. 17.—Scions of the seedling plum referred to in Figure 16 grafted directly into apricot limbs. The growth of the plum branches, where double worked with sections of Pond (*Hungarian prune*) wood between the plum and the apricot, is appreciably more vigorous than in the present case. This obviously suggests, although it does not prove, that double working in this combination is advantageous.

rob each other of their needed moisture supply. For trees naturally thrifty and planted for a permanent orchard 20 feet each way is generally considered the best distance. In fertile well-watered soils 26 to 28 feet each way is believed best for naturally large-growing prune trees.

Planting too close has been the cause of many light fruit crops, of alternate bearing of trees, and of the generally poor production which

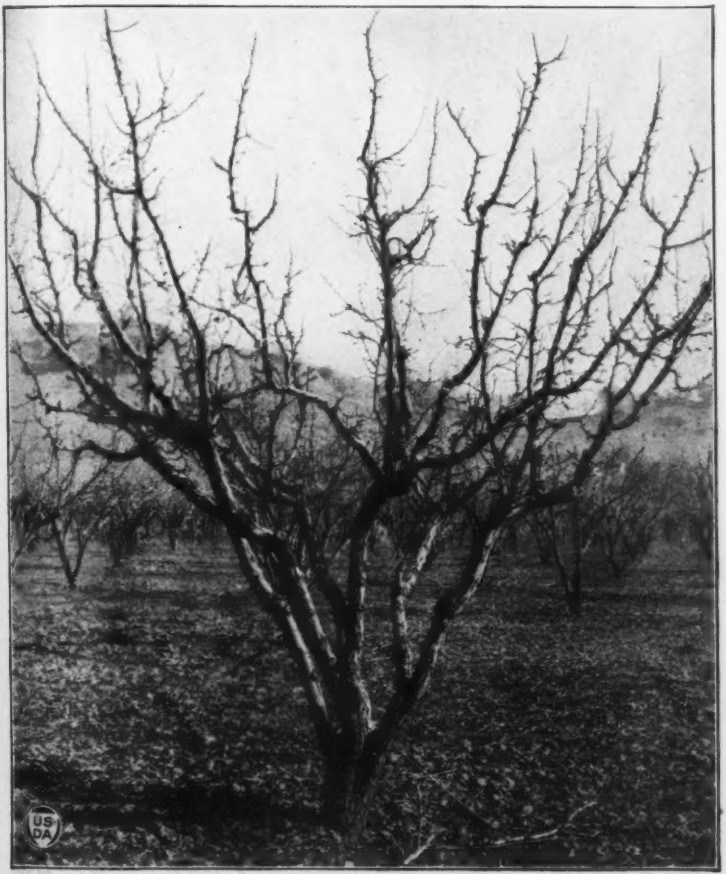

FIG. 18.—The Formosa plum, an upright-growing variety, top-grafted on a 5-year-old peach tree to make an open top. (Vacaville, Calif., January, 1921.)

is common in some districts. If close planting is practiced where the soil is of only average depth and quality, or where irrigation is lacking, or where culture is in part neglected, only irregular crops and slow, weak growth may be expected after the trees are a few years old and the roots have occupied all the land. Where ideal cultural conditions prevail, with a pruning program suited to the variety and conditions, fair yields may be expected even with close planting. (Fig. 22.)

XUM

NURSERY TREES FOR PLANTING.

One-year-old trees of average size are considered most suitable for orchard planting. All trees should be propagated on the kind of stock best adapted to the land to be planted, and all should be free

FIG. 19.—An Agen (*French prune*) tree top-grafted on an almond stock. The union between the almond and the prune wood is poor, and the growth of the prune top is unsatisfactory. Sprouts have been allowed to grow on the almond portion of the tree for the purpose of nourishing the roots. In some instances this practice has resulted in a marked improvement in the general condition of the tree. It would appear that in this case almond roots can maintain the Agen prune top, but that the food material elaborated by the latter does not adequately maintain the almond roots.

from injurious insects and plant diseases. Provided the interstate and intercounty quarantine regulations have been properly carried

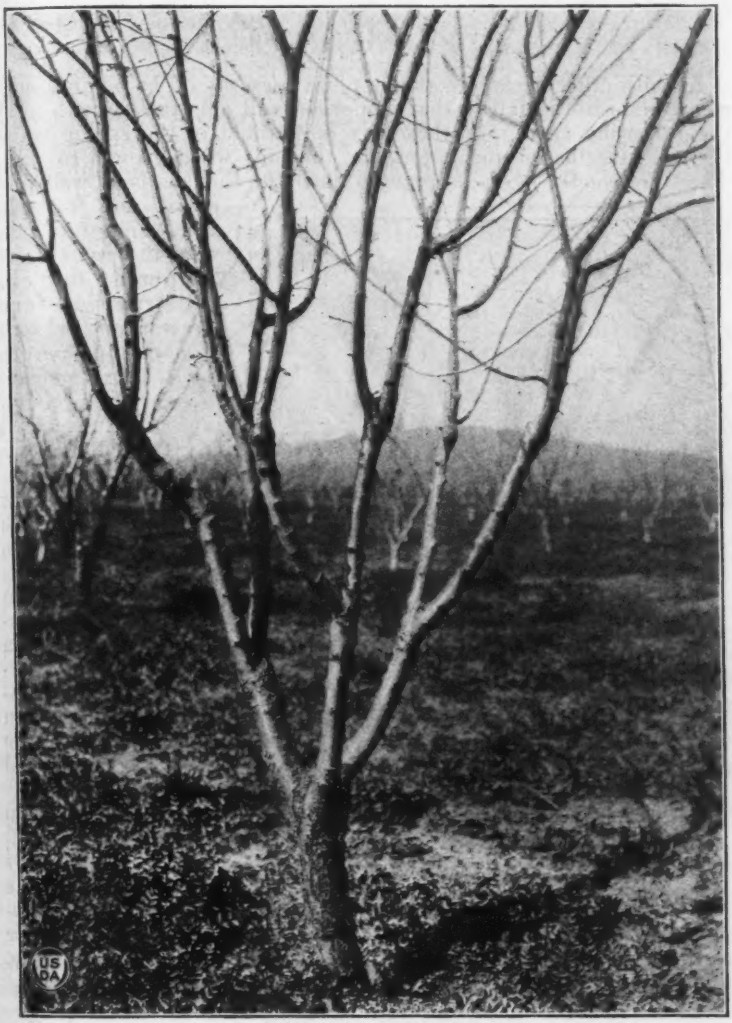

FIG. 20.—An almond tree the main limbs of which, like the one shown in Figure 21, have been top-grafted to the Agen (*French prune*). This tree stands next in the row to the one shown in Figure 21, but the congeniality between the almond and the prune appears to be satisfactory, and the tree is thrifty. A varietal strain or other obscure factor may explain the difference in the congeniality in these two instances.

out, there will be but little risk in regard to insects and diseases when buying a nursery tree, and the purchaser should make sure that all provisions of the law pertaining to the sale of nursery trees in his

locality are strictly adhered to. Nursery trees with a well-developed system of thrifty roots and of average size rather than very small or extra large should be chosen.

TIME FOR PLANTING.

As with other deciduous fruits, plum trees should be planted sufficiently late in the fall so that new wood will not start growth until the following spring, or they may be planted in the spring while the soil is still cool and before the time for wood growth to start. The trees should never be planted until the soil has been well prepared and is sufficiently moist to prevent the roots from becoming dry. In California, western Oregon, and western Washington, where the winter temperatures are mild, plantings may be made at any time during the winter and even until after the 1st of March, with little fear of injury to the trees.

FIG. 21.—Sun scald and decay in a peach stock which resulted from top-grafting with an uncongenial variety of plum, followed by neglect in caring for the stumps of branches removed in top-working.

Loss of trees from carelessness is a common occurrence in newly planted orchards. Where planting is for any reason delayed after the trees are received from the nursery they should be heeled in carefully in a light, moist soil until ready for planting. Care must be taken to protect the trees from the sun and drying winds while handling, for neglect at any time from digging in the nursery until planting in the orchard may result in loss or delay in growth.

ORCHARD CULTURE.

The cultural operations as practiced in most commercial plum-growing centers of the Pacific States are a combination of cultivation, irrigation, and the growing of cover crops. Where water for irrigation is available these operations are closely related, and the performance of one is often dependent on the other. In nonirrigated sections cover crops must be handled at the convenience of cultiva-

tion. As the annual rainfall at the plum-growing centers of these States is confined to the fall and winter seasons, occurring mostly while the trees are dormant, and as the summers are hot and dry, the moisture content of the soil depends much upon cultivation if irrigation is not practiced. Under these conditions it is the custom to plow to a moderate depth as early in the spring as the soil becomes sufficiently dry to work well, following the plow with some tillage implement designed to smooth and loosen the surface.

Too much care can not be given to the choice of the time for this spring plowing. If the soil is worked while too wet, so that it is

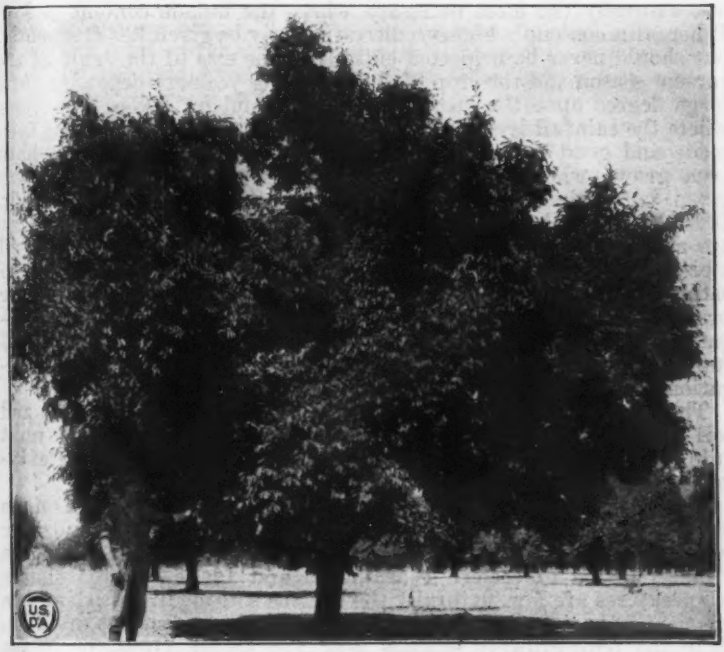

FIG. 22.—A 30-year-old Italian prune tree which is prolific and bears regularly while standing where it is not crowded. Under similar soil conditions in a near-by orchard, but with the trees planted 18 by 18 feet, the growth of the trees is poor and the production irregular. (Douglas County, Oreg., August, 1921.)

compacted, as in the case where the surface of the furrow is left shining when it is turned by the plow, the soil will dry out hard and only an ineffective soil mulch can be established. In this condition the moisture content below will be endangered and disintegration in the compact soil delayed, with the result that the development of the food supply for coming years will be retarded. Adobe soils, which in some localities are planted to plums, must be plowed when wet, but such soils crumble or slake to some extent upon drying and may then be worked to the desired texture. On the other hand, if the soil is too dry when first plowed the operation will be difficult and

usually poorly done. The soil will turn up cloddy and only an ineffective soil mulch can be formed, thereby permitting further drying of the subsoil. When the moist soil crumbles into small particles upon leaving the plow, covering well all vegetation, subsequent tillage is more effective and conditions for the fruitfulness of the trees much better than if the land is plowed when either too wet or too dry. During the remainder of the summer, shallow-going tillage implements are used at intervals to maintain a surface soil mulch for the conservation of soil moisture.

These shallow cultivations are most effective where there is a good humus content in the soil, although the objects to be attained by them are naturally the most necessary where the humus content is low. Where this content is higher, cultivation may be given less frequently, but should never be neglected entirely. The size of the fruit of the current season and the crop of the following year are dependent to a large degree upon the quality of the soil mulch. Even in sections where the rainfall is exceedingly light a thrifty tree growth has been made and good crops of well-sized fruit of excellent quality have been grown when frequent and thorough surface cultivation was given, but without it small crops and poor tree growth will result. It is claimed by both growers and buyers that plums from soils that are nonirrigated but sufficiently well cultivated to conserve the soil moisture necessary for a normal growth of the trees are better in eating quality, carry better when shipped fresh, and dry into heavier prunes than when grown on land where frequent and abundant irrigations are given, such as are necessary for maintaining a sufficient supply of moisture in the soil if there is no cultivation between irrigations.

The number of cultivations required under the local climatic and soil conditions must be determined by the orchardist, who must fulfill but not exceed the demands of economy in his orchard cultivation expenses.

Temperatures and prevailing winds have a strong influence on the evaporation of soil moisture and therefore on the demands for summer tillage. In the highland orchards, such as those in the Palouse region of eastern Washington and Idaho, where summer temperatures are low, naturally the surface soil requires stirring less frequently than in the sections where summer temperatures are high, as in the fruit-growing sections near The Dalles, Oreg., or in the interior valleys of California.

To eradicate noxious weeds, of which the grasses and the morning-glory are the most troublesome, frequent plowing instead of the use of shallow-going implements for stirring the surface soil is necessary.

Where cover crops are grown in nonirrigated sections care must be taken that plowing be done when the soil is in the proper condition. Spring plowing is sometimes delayed to permit a heavier growth of the cover crop, but with questionable benefit in nonirrigated sections, since in such sections soil moisture is the principal limiting factor to successful plum production. Cover crops are highly desirable if their growth is made during the fall or before the soil has become sufficiently dry for plowing in the spring, but not so if grown at the expense of moisture which should be retained for the trees by cultivation.

Systems of tillage and cover cropping are considerably modified in irrigated sections as compared with those nonirrigated. Under irrigation the soil moisture taken by the cover crops may be replenished, cultivation to conserve moisture made less necessary, and cover crops managed more to the pleasure of the orchardist. The soil may be prepared at any time for seeding these crops and moisture for their germination and growth provided by irrigation. If, owing to miscalculation in the spring, the soil becomes too dry to plow well, water may be applied, although it is considered better to plow when the soil first reaches the proper condition than to allow it to become dry. It is a common practice after this plowing to go over the orchard once or twice with a disk or drag harrow, giving no further cultivation except the necessary furrowing for irrigation until the time for seeding a fall cover crop. This method, though in general practice, could be greatly improved by giving some surface cultivation. Where water is scarce or expensive, irrigation is delayed as long as possible in the spring, and unless the orchard has a permanent cover crop it is the usual custom to water not more than once, if at all, after the fruit is harvested. This is in early summer in the sections of California from which fruit is shipped fresh. This often allows the soil to become too dry for the best development of the fruit buds and fruit for the following year. It also causes a shortening of the growing season, due to lack of moisture in the fall, and consequently a low food reserve for tree development and fruit production. To conserve the moisture after the winter rains and again after irrigating thorough surface cultivation can not but prove profitable.

Where there is a hard stratum within reach of the subsoiler with open fertile soil below, subsoiling and blasting to break up this stratum are sometimes practiced with good results. Such soils are rarely suited to growing late-maturing varieties for either shipping fresh or drying for prunes.

IRRIGATION.

On account of the semiarid and arid conditions prevailing in nearly all plum-growing sections of the Pacific States, irrigation is looked upon as essential in many districts and highly desirable in all. A large percentage of the area devoted to this crop is now under irrigation. Where thorough tillage is given, however, especially in the cooler sections and where the soil is naturally retentive of moisture, many growers believe that the returns from their orchards would not be sufficiently increased to justify the expense of installing irrigation systems. In a few places either insufficient water or tillable land areas too small to be suited for fruit growing make irrigation impracticable.

The method most commonly followed in applying water in irrigated orchards is either flooding, accompanied by checks, or admitting the water to small open ditches or furrows running parallel with the tree rows.

For irrigation where the water passes down slowly or where heavy applications are desired, as in the deep fertile soils used for prunes, flooding is more common than watering in furrows. In such places cultivation should follow flooding, to prevent the soil from cracking and to conserve the soil moisture, thereby preventing the

XUM

rapid change of conditions in the soil and lessening the necessity for frequent irrigation. Where flooding is practiced during the fall or winter less care need be given to cultivation following it.

Ditches for irrigation are made by furrowing with a plow, and from one to a half dozen furrows are made in the space between rows. If moisture moves out freely from the furrows or water is scarce, a furrow on either side of the row is, in some cases, all that is used, but where water is plentiful and the soil such that the water percolates through it slowly more furrows are needed. On hillside plantings a furrow on the uppermost side of each row is sometimes considered sufficient. As the highest concentration of available plant food is near the surface and the soil there is best suited to root growth and activity in absorbing nutrients, the furrows for irrigation should

FIG. 23.—A portion of an Agen (*French prune*) orchard on deep fertile soil which was irrigated in former years but not the current season. The leaves are wilting and dropping prematurely and the trees otherwise suffering from lack of moisture. (September 20, 1921.)

be so close that moisture from one furrow will meet that from the next immediately below the soil mulch. In most soils water goes rapidly downward with but little lateral movement. This movement quickly carries much of the irrigation water below the feeding roots and leaves broad dry areas between the furrows if but one or two furrows are made between tree rows. A considerable portion of the soil is thus utilized but poorly, if at all, by the roots during the dry summer when the tree should be storing food at its maximum capacity. With bearing trees which have a broad spreading root system, this results in a decided handicap to the tree and consequently affects the profits from the orchard. In making furrows for irrigation, shallow ones are best on shallow or compact soils where the lateral movement of water is slow; but in deep loamy open soils where the root systems are deep and there is a free lateral movement of water

through the soil, deep furrows are best, as they leave more dry surface mulch, therefore lessening the cultivation that is necessary.

The frequency with which irrigation should be made and the quantity of water to be applied depend much on local soil and climatic conditions, the variety of fruit grown, the cultural practices followed in the orchard, and the prevailing price of water. When the soil is light and well subdrained and water moves rapidly downward frequent light applications are considered better than fewer heavy ones. Soil inclined to be heavy needs water less frequently and in greater quantities, the number of irrigations depending upon cultivation. In sections where water is expensive and the supply limited only one application is given in the summer, usually a few days before harvest, if the plums are for the fresh market, so that the fruit may reach the largest size possible. Where there is an

FIG. 24.—A portion of the orchard shown in Figure 23, which has received moderate irrigation the current season. The better condition of this part of the orchard as compared with the nonirrigated part is apparent. (September 20, 1921.)

unlimited supply of water and the charges for it are low it is often the practice to give frequent and sometimes heavy irrigation. But under this method the soil soon becomes compact, aeration of the subsoil is hindered, and naturally an unthrifty root system develops. Where the soil is deep, moderately well drained, and irrigation water is expensive, as is the case in by far the greatest part of the plum-growing sections of these States, it is the usual practice to give moderate irrigations at as widely separated intervals as conditions will permit. Four or five waterings during the summer are considered by many to be necessary, and weekly irrigations are given by some orchardists where water is inexpensive. Many orchards, however, are maintained in a thrifty condition during the long dry summers with only two or three waterings, followed by cultivation. (Figs. 23 and 24.)

XUM

Irrigation should not be substituted for cultivation to obtain thrifty trees and profitable crops in orchards, but should be resorted to for the purpose of supplementing it in order to maintain the soil moisture at the point of greatest efficiency for tree and fruit development. (Fig. 25.) Most plum orchards, especially those where late-maturing varieties such as are used for prunes are grown, are located on soils easily tilled and naturally retentive of moisture. For such no definite rule for applying water need be given. The orchardist must judge the needs of his trees by their apparent vigor and be guided by the extent of cultivation he is able to give.

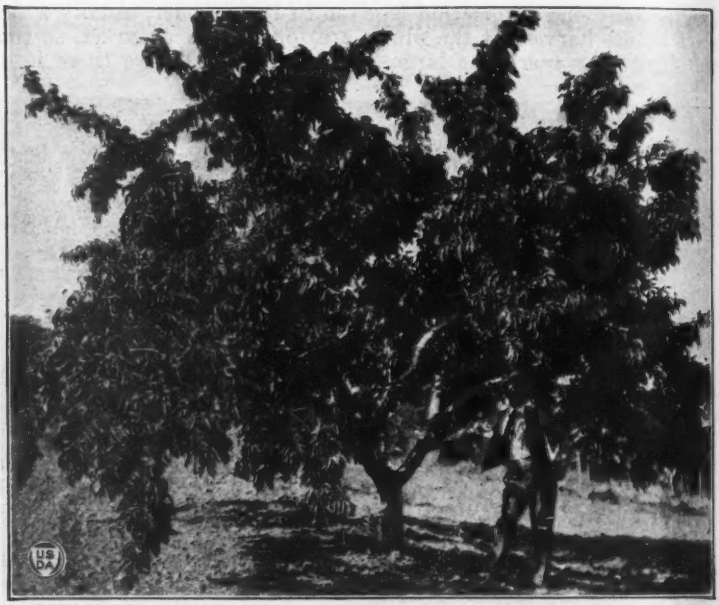

FIG. 25.—An Italian prune tree in the nonirrigated rolling section near The Dalles, Oreg., where the summers are hot and dry. An excellent soil mulch is maintained in summer by frequent tillage. In this section the tree tops are thinned out and the branches shortened by annual pruning. The trees are vigorous and productive of excellent large fruit.

It must be remembered, when considering irrigation, that drying of the soil causes severe injury to the feeding roots and that frequent moistening and drying is decidedly less beneficial to the tree than keeping the soil constantly in good condition, which can be accomplished best by moderate irrigations followed by surface cultivation.

Where an accumulation of alkali endangers the thrift of the tree irrigation water may be used to decided advantage in washing out and carrying away these soluble soils, provided the soil is of such texture and slope that a good head of water can be forced across the orchard and the excess carried off in drains. In this operation the alkali-laden waters must not be allowed to accumulate in low places in the field, thereby merely shifting rather than removing the trouble.

COVER CROPS.

The use of cover crops has become common but by no means universal among plum growers of the Pacific States. The need for these crops in this region is generally recognized, as the soils for the most part are low in organic matter and available nitrates. Since the summer rainfall is light, the development of moisture-retaining qualities is highly desirable. Rank-growing leguminous plants, which will furnish a large quantity of organic matter as well as store nitrogen taken from the air, are always preferred and are the only ones in general use, although the wild vegetation made up of nonleguminous plants and weeds as well as leguminous plants is sometimes allowed to grow in the orchard.

Both perennial and annual plants are grown for cover crops. In the irrigated sections of eastern Washington, eastern Oregon, and Idaho perennial crops are planted almost to the exclusion of annuals, while with but few exceptions annual plants only are used in the sections of Oregon and Washington west of the Cascade Mountains and in California. Among perennial cover crops alfalfa is the one in general use, although red clover is still grown in a few orchards. Alfalfa has been grown experimentally in orchards for a number of years and recently has been adopted by the larger percentage of plum and prune growers in localities where perennial cover crops are grown.

Where the soils are very fine grained and lacking in humus they become very compact under irrigation and cultivation, and the movement of irrigation water into them is naturally very slow. It is believed that the filtration of irrigation water through such soil is decidedly facilitated by the growing of a permanent crop of alfalfa, and this is largely the reason for its general use. At the same time, the nitrogen and humus provided by it are much needed and are responsible for the increased vigor and production of the trees.

Alfalfa is not always managed as a cover crop when grown in the orchard, but more commonly as an intercrop, although planted primarily for the benefit of the trees. As it is a deep-rooted vigorous plant, it requires a deep fertile soil, such as is commonly planted to late-ripening plums. It not only will not succeed well but will result in injury to the orchard if the soil is shallow. As alfalfa requires large quantities of water, provision should be made for irrigation before the seed is sown, or at least the ground should be leveled and the main lines for irrigation established. Whether planted in newly set orchards or in older ones, a good seed bed should be prepared for the alfalfa. It is a common custom to seed the entire surface, although planting in the areas between the rows is sometimes practiced, especially if irrigation water is not plentiful.

When the alfalfa has made some growth, it is important that the period between irrigations should not be too long. The benefit from the loosening of the soil by the alfalfa roots for the free passage of water is not apparent for the first few months after planting, although both the crop and the trees are drawing heavily upon the moisture near the surface during this time.

Water for the alfalfa crop is usually applied in from two to five furrows between rows of trees, the number depending upon the

XUM

soil type and the ability of the water to pass laterally through it. The applications must be at rather frequent intervals and most often when the alfalfa is making a rapid growth after a harvest. Less water is needed after the alfalfa has reached full growth in orchards where it is not harvested but grown as a cover crop only. To realize large returns from the hay, some growers irrigate sufficiently to induce a rapid growth of the alfalfa; but in places where the subsoil drains poorly the trees are seriously injured by an excess of water about their lower roots. To give the quantity of water required for the best growth of the alfalfa may easily result in poor crops of fruit and greatly shorten the life of the orchard. An excess of subsoil moisture in orchards where alfalfa is grown is indicated by small leaves and a lack of vigor in the growth of the wood of the current season and finally by the loss of a tree here and there. On shallow or thin soils the same indications may appear, and on such soils alfalfa should not be used.

The method of handling the alfalfa crop, whether grown for hay or for a cover and soiling crop only, depends upon the individual orchardist. When to be made into hay, the number of cuttings is usually the same as in adjoining alfalfa fields, although it is becoming a more common practice to make but one or two harvests of hay, leaving the later growth for working into the soil. The entire summer's growth is left for this purpose in a large number of orchards, and this practice is rapidly growing in favor.

Where the alfalfa is not harvested the heavy crop of vegetation for working into the soil supplies an abundance of humus, forms an excellent mulch to protect the surface soil from drying out quickly, and maintains a more equitable temperature for root growth in the surface soil than where frequent cuttings of hay are made or clean culture is practiced. The alfalfa does not require as much water when not harvested as when frequently cut, and where fewer irrigations are necessary there is a more uniform moisture content in the soil. It is often claimed that the water necessary for the plum orchard under clean cultivation equals that where alfalfa is grown but not harvested, while the tree growth and fruit production are decidedly greater. Where cut for hay, a harvest is usually made just as the fruit is ripening, to make fruit picking easier; and where it is allowed to remain on the land, the crop is broken down with a roller or disk or cut with a mower and then worked into the surface soil, so as to be out of the way of the harvesting crews.

Where alfalfa is grown as a permanent cover crop it is necessary occasionally in most places to plow under the old crop and seed a new one. This is due, in part at least, to the alfalfa being gradually crowded out by weeds and grass which grow from seed carried in by irrigation water.

Red clover, when planted for a permanent orchard cover crop, is managed in the same way as alfalfa. On account of its shallower root system the planting of it has been almost entirely replaced by alfalfa. (Fig. 26.)

Perennial cover crops are rarely grown in plum and prune orchards in western Oregon, western Washington, and California, but annual ones are planted or the growth of weeds and other plants that develop without hand seeding is encouraged in most

orchards. Vetch and melilotus are the most favored crops for planting in these sections. Oats, barley, or some other small grain is sometimes planted as a cover or soiling crop, either by itself or with vetch to support it in the spring and to prevent its being blown down or lodged by rain. Except for the purposes just mentioned, small grains and grasses are not recommended as cover crops in the plum sections of the Pacific States if leguminous or other more suitable plants can be grown successfully. Bur clover is among the most commonly grown plants adapted to a wide range of soils and well suited to the climatic conditions of the plum-growing regions of California. It is a vigorous grower, easy to manage, a very satisfactory cover crop, and may be plowed under during the spring like other annual cover crops. To perpetuate it without the expense of reseeding, occasional plants are allowed to remain undisturbed, or the

FIG. 26.—Red clover as a cover crop in an Italian prune orchard in Idaho. (August, 1921.)

tips are left uncovered when plowing. These blossom and ripen seed, which remains in the ground for growth the next fall.

Annual crops are sown late in the summer, sometimes immediately after the first fall rain, or, if rains are late, after an irrigation. To insure quick germination the seed is often sown on the surface and not worked into the soil. If covered, a portion of the seed may not germinate until the following spring, possibly too late for the plants to make a satisfactory growth before plowing. After seeding no further attention is given the cover crop, as the fall and winter rains are usually sufficient for a good plant growth. When the winter and early spring temperatures are moderate, a good growth is usually made by the cover crop; but if the growth has been slow, spring plowing is sometimes delayed for a few days after the soil has become sufficiently dry for plowing to permit the growth of the cover crop.

XUM

This practice, however, is often attended with doubtful or injurious results.

A poor growth of the cover crop is often noticed in old orchards where clean cultivation has been practiced for a number of years and in localities where the soil is lacking in available nitrogen. A number of places have been observed where the growth was exceedingly poor except in portions of the orchard where stable manure or commercial fertilizers had been applied. In those places a rank thrifty growing crop was found.

INTERCROPS.

Intercropping is often practiced in plum orchards on high-priced land. Among annual crops beans, corn, pumpkins, and garden crops are planted extensively, usually profitably, even where the soil is of

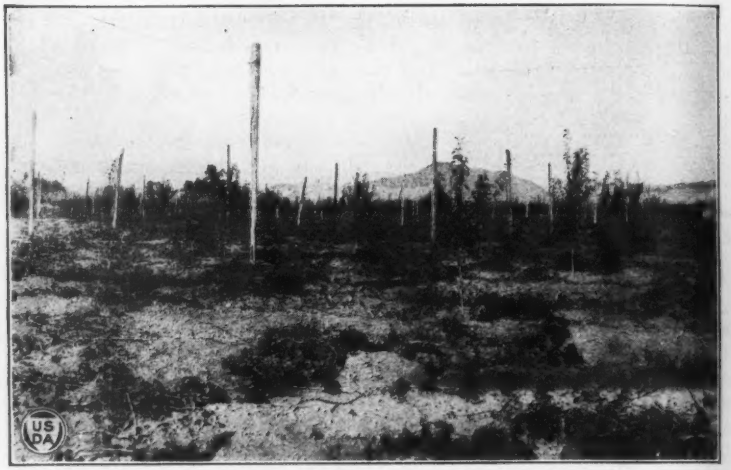

FIG. 27.—A 2-year-old Agen (*French prune*) orchard interplanted with hops. The hop harvest had just been completed. (California, September, 1921.)

only moderate depth, if water is plentiful and good soil management practiced. Where such crops are grown the results indicate that they are decidedly preferable to small grains and grasses. Aside from alfalfa, the perennial crops used for interplanting with plums include hops, walnuts, other deciduous fruits, and berries. (Figs. 27 and 28.) Each of these crops is confined to a more or less restricted set of conditions, and all need fertile soils. Hops are sometimes planted at the same time as the prune trees, or if prunes are planted in the hop field the hops are allowed to remain until the trees are a few years old. The time for removing them depends on the relative value of the two crops, but they should not be left longer than four or five years after the prunes are planted. This practice is most common in some of the warm valleys of California, where both hop and prune growing are well-established industries. Where Persian walnuts are planted with plums it is usually the plan to remove the plums when the walnuts have come into bearing. This

plan is also followed with other deciduous fruits, but sometimes both crops are planted with a view to deciding which shall be the permanent orchard when both have come into bearing. The use of vegetables and berries as intercrops is usually discontinued when the plum trees approach full bearing.

PRUNING.

At the time of setting in the orchard, the nursery tree, which is usually a whip, is cut back to a bud where the uppermost branch for forming the head is desired. This height varies greatly with different growers and with the variety and the purpose for which it is grown. With those grown for their fresh fruit, 2½ feet is about the height preferred for cutting back the young tree, particularly those which are most inclined to be upright in growth, such as most Japa-

FIG. 28.—A young Agen prune orchard with an intercrop of winter cauliflower. (Santa Clara Valley, January 23, 1922.)

nese varieties. The same height, or even a lower head, is favored by growers of the Agen (*French prune*), especially in California. In States farther north, where the Italian prune is the important variety, the nursery tree is cut back to a height of 3 to 3½ feet or even more for the formation of the tree head. (Fig. 29.) The height at which the branches are to be produced should be determined by the habits of the variety (whether spreading or upright), by the implements to be used in cultivation, and by the disposition to be made of the fruit. If the fruit is for fresh shipment, low branches make the harvest easier; but for growing prunes, where the fruit is shaken from the trees, the formation of the tree head may be somewhat higher without particular disadvantage except that the danger of injury by sunburn on the trunk is increased.

Three branches are usually desired for forming the lower framework of the tree, although some growers prefer four or five. These

branches are selected from among those attached to the upper part of the trunk, care being taken to select strong branches separated by several inches along the trunk and at distances as nearly equal as possible around it.

Where these main branches are allowed to grow near the same point on the trunk, a pocket which will hold water and collect dust, falling fruit, and leaves is often formed within a few years by the increasing diameter of the branches. This makes an easy entrance for wood rots, resulting in the loss of many limbs and the weakening of others, so that they are easily broken down by heavy loads of fruit or by windstorms. Where four or five main branches are allowed to grow in forming the tree, the danger of the formation of such a pocket is obviously increased. (Fig. 30.)

To induce further branching of the young tree, the limbs which develop the first season after the tree is planted are, in turn, cut back the following winter, or they may be lightly pinched back dur-

FIG. 29.—High-headed Italian prune trees in an orchard intercropped with potatoes. (Clarke County, Wash., August, 1921.)

ing the summer when they have reached the desired length. The same practice is followed in succeeding years to induce further branching.

Superfluous branches should be rubbed off when they first appear, or they should be removed not later than the winter after their first season's growth. In selecting the branches which are to remain, much can be done toward directing the shape of the tree and developing a formation that will enable it to hold heavy crops of fruit. Where too many branches are left or some have grown at an undesired angle they may be removed, so as not to interfere with the best development of the tree.

With top-grafted trees, much can be done toward establishing the framework the first year, as at this time the new wood makes a vigorous, rampant growth and may be pinched back three or four times during the summer, thus establishing as many points of branching. (Fig. 31.) Such pinching back causes the growth of a great

number of branches, and those not needed may be removed when they appear or may be left until the regular time for pruning during the dormant season.

Many have followed the custom of severely heading back all varieties of plums each winter until a considerable production of fruit is reached, in order to favor the development of a stocky vigorous tree, but this system is being gradually abandoned except for the first year, after which the branches are only thinned out or cut to laterals to form a more open tree. In this way the young tree makes a greater growth and comes to bearing earlier than where severely cut back each winter. The practice of cutting back to laterals and removing only superfluous branches is coming into more general favor on irrigated lands where soils are fertile and a thrifty new growth is assured. The old method of pruning is still used in some sections, especially in nonirrigated orchards where new growth is slow and for some varieties which are spreading in their habits of growth, grow slowly, and are not naturally vigorous.[6]

FIG. 30.—A plum tree composed of several main limbs which started from points close together on the trunk. As the limbs increased in size a pocket was formed where they came together. Wood-decaying organisms found entrance here, thus weakening the limbs, some of which have broken down.

In the pruning of bearing trees there is considerable divergence in practice. With varieties grown for prunes the branches, as a rule, are thinned out rather than cut back, and in many instances no pruning is performed or only dead branches removed. Where grown for the fresh fruit, more thinning out is done with many varieties, especially the Japanese sorts, and in some sections severe

[6] For further information on this subject, see the following bulletins:
Tufts, Warren P. Pruning young deciduous fruit trees. Calif. Agr. Exp. Sta. Bul. 313, p. 111–153, 24 fig. 1919. Literature cited, p. 150.
Kraus, E. J., and Kraybill, H. R. Vegetation and reproduction with special reference to the tomato. Oreg. Agr. Exp. Sta. Bul. 149, 90 p., 22 fig. 1918. Literature cited p. 87–90.
Morris, O. M. Prune growing in western Washington. Wash. Agr. Exp. Sta. Pop. Bul. 120, 21 p., 7 fig. 1920.

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annual cutting back is customary. On the thinner and poorer soils and in nonirrigated sections the practice of cutting back the 1-year wood is more general than elsewhere. Methods favored or particularly successful in one locality are naturally carried into neighboring

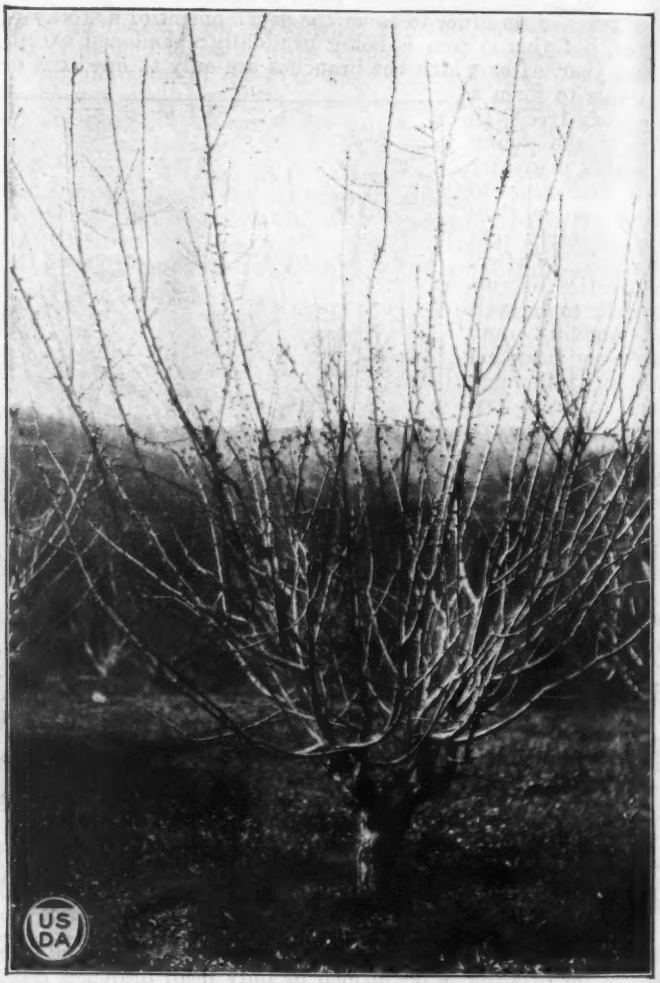

FIG. 31.—Three-year-old President plum grafts top-worked on a peach tree. The new plum growth was pinched back three or four times during the first season after grafting. This caused the growth of many branches that season, some of which should be removed.

ones, although conditions for wood growth there may be decidedly different and poor results may follow. The annual wood growth is normally short on the drier soils; on all but the deeper soil types in such places varieties for the production of fresh fruit are grown.

Good prices for the fruit can be realized on large sizes only, and severe cutting back of the previous season's wood growth is relied on to insure large sizes of fruit. In some dry places where the annual growth is normally short, even on heavily pruned trees, if cutting back is not practiced it will be exceedingly short after a year or so, and poor production and lack of vigor in the tree may be expected.

On irrigated soils which are considered insufficiently deep for planting to varieties for prune making, but where plums for fresh shipment are grown extensively, cutting back the new wood is widely practiced. Under these conditions some growers cut back lightly the growth of the previous year and with varieties of the domestica group confine their pruning mostly to the thinning out of branches. With the Japanese plums, which are naturally vigorous growers and bear their fruit on spurs on wood of all ages, more cutting back of 1-year-old wood, as well as the thinning out of branches, is practiced, to insure a vigorous wood growth and large-sized fruit. In this instance, pruning is used partly as a means of thinning the fruit or, rather, of reducing the crop and distributing the load over the tree. Where heavy cutting back is practiced the trees are called upon to produce a crop of both wood and fruit. The soil can not be expected to sustain a profitable orchard where the toll for each is heavy.

Trees of varieties grown for prune production bear most of their fruit on wood 1 and 2 years of age. A thrifty wood growth should therefore be made by the tree each year. If not thinned out or occasionally cut back the twigs soon become too numerous for the tree to produce a satisfactory terminal growth, and a poor terminal growth results in small or irregular crops of fruit. On the other hand, removing the bearing wood will naturally prevent a good crop the following year. Under conditions most favorable for wood growth by varieties which naturally make a strong growth, less thinning out of the twigs will be necessary. Where thinning out the branches and occasionally cutting the terminal growth back to laterals is not sufficient to induce the growth of several inches of vigorous new wood at the ends of the twigs during the summer, a change in methods of culture should be resorted to for stimulating more vigorous growth.

The growing and fruiting habits of the individual varieties should be closely observed and should guide the pruner in his work. Varieties inclined to make a compact upright growth, such as the Santa Rosa or Wickson, should be pruned to induce spreading. Those naturally spreading, such as the Burbank, should have their long lateral-growing branches shortened to facilitate cultivation and to encourage the growth of strong upright branches which can carry a heavy load of fruit and provide shelter from the sun for the main trunk. Varieties which bear fruit on spurs on older wood should be kept open for the admission of sufficient light to develop fully the foliage of such spurs. This can be accomplished best by moderately thinning out the new wood. Severe cutting back will result in a vigorous new growth, which tends to shade and prevent spur development. Too little pruning, on the other hand, often results in the stagnation of growth of these spur-forming varieties, with consequent poor production. Excessive pruning of the upright-growing varieties of Japanese plums causes a rampant growth and a tendency to form

XUM

long barren poles, on which fruitfulness is delayed, even if spurs form on them at all. Among varieties which under good growing conditions make some terminal growth on which they bear most of their fruit the following year there are variations in tendencies which should not be overlooked in pruning. Excessive cutting back will cause a heavy new growth with these as with other varieties, while no pruning tends to cause the formation of spurs and inactivity of growth of such spurs. This occurs at least on varieties or individual trees where little or no terminal growth is made, with a resulting decrease in fruit production. With the dying out of some spurs and the loss of others broken off in harvest and cultivation, the fruit-producing portion of the tree is seriously reduced year by year. This is naturally most apparent where the orchards are on poor soils or where there is a shortage of soil moisture.

With some varieties a short terminal growth with occasional branching continues without the formation of spurs or any upright vigorous growth, and gradually long, slender, drooping masses of unfruitful twigs will develop. Trees of the Italian prune often illustrate this. These differences in habits in the growth of wood and fruit spurs may be well illustrated by the Agen and Pond varieties and by the Giant, which is a cross between them. The Agen variety, if left unpruned, will continue the growth of all its branches with a gradually shortening annual wood growth, and at the same time the fruit gradually will decrease in size, provided good crops are matured. When left unpruned the Pond will quickly stop its terminal growth. The dying out of many spurs and the poor leaf growth of others exposes the fruit and wood to the sun, often resulting in sunburning. The Giant, although losing some of its spurs, will continue a fairly vigorous growth of all its terminal branches and twigs and produce a good crop of normal-sized fruit.

It should be remembered in all pruning that the work should be carefully performed with sharp tools. Where a wound is made which will not heal over quickly, as when a stub is left that is too long, or split branches are not removed, or where the bark is torn or a wound left by the removal of a large branch, there is danger of the entrance of wood decays. The careful selection of branches when shaping the young tree and later in pruning, so as to make unnecessary the cutting out of large branches, and the careful manipulation of pruning tools will prevent serious losses later.

FRUIT THINNING.

Thinning the fruit is often important in plum culture. It is seldom practiced where the fruit is grown for prunes, but many varieties cultivated for their fresh fruit require it. Thinning is done primarily for the purpose of allowing the fruit which remains on the tree to become larger, so that higher prices may be received for it, but thinning also relieves the tree of some of its weight and tends to prevent the breaking of branches and to reduce the number of props required, thereby better enabling the tree to bear regular crops of fruit. Pruning out superfluous twigs during the dormant season and also after the fruit has set is a cheap and efficient means of decreasing the load of fruit, but hand thinning, in order to leave the fruit properly spaced

on the tree, is often necessary. Hand thinning should be done as soon as all danger of spring frosts is over, so that the tree may be relieved of its excessive burden as early as possible.

Thinning is necessary almost every season with some varieties of the Japanese group, such as Beauty and Burbank, and is less so or not at all necessary with many varieties of the domestica group.

PROPPING AND BRACING.

Artificial supports are often necessary to prevent the breaking down of fruit-laden branches. Slender boards are used for this purpose and are put in place when the branches start to bend with their burden of fruit.

Wires to fasten opposite branches together, thus preventing their being broken by loads of fruit, are used in a number of orchards. This means of support is considered by many a satisfactory substitute for the use of wooden props. A number of methods of using wire for supporting branches are employed, the most common being to fasten a small wire to the inside of each of the large branches with a screw eye, or staple, and connect them to a ring in the center of the tree. If it is not convenient to fasten the outer branches to the center ring they may be wired to a branch which has been given support. Connecting the outer branches with a wire without the use of a ring in the center is a method favored by some.

The use of wire supports has the advantage of requiring but a small outlay for material, is fairly permanent, and does not interfere with cultivation, irrigation, and fruit picking, as do wooden props. There is often loss of branches by breaking where props are loosened and fall when strong winds sway the trees. This is avoided by the use of wires.

Where weakness is found, due to an unsatisfactory crotch, or where a large limb has been partially split down, long bolts put through the trunk or limb have been used for giving permanent support.

The necessity of branch supports may be partly eliminated by pruning, so that wounds will heal quickly and in a manner to develop a strong framework, by thinning the fruit, and by preventing injuries to the tree from sun scald and diseases which cause wood decay.

FERTILIZERS.

Wherever animal manures have been applied to plum orchards in the Pacific States excellent results have followed. Owing to the shortage of such fertilizers, however, comparatively few orchards have been so treated. Quickly available forms of nitrogen have been used in a number of instances to cause a heavier setting of fruit. For this purpose fertilizer is broadcasted about the trees three or four weeks before the blossoms appear. Many growers claim that decided benefits have followed this treatment.

FRUIT HARVEST.

The plum harvest starts as soon as fruit enough to warrant a shipment reaches sufficient maturity to ripen while in transit to the market. This is late in May for the earliest varieties in some sec-

tions of California. The harvest of other varieties continues until August in that State and until late in September in some places in Washington where summer temperatures are lower. With some of the Japanese varieties, the fruit of which is very juicy and therefore easily bruised, little delay can be allowed for harvesting after the fruit reaches shipping condition. Many of the domestica varieties, however, have a texture which enables them to become fully ripe on the tree and still reach distant markets in good condition. Fruit that ripens slowly in sections where summer temperatures are moderate or low is sometimes allowed to remain on the tree for a period after reaching maturity, without injuring it for market.

Under average conditions plums ripen unevenly over the tree. Therefore two or three pickings must be made, although one or two may be sufficient for varieties where the fruit is allowed to become well ripened before picking. Harvests are usually three or four days apart, but this period is determined by weather conditions and the variety.

As badly bruised fruits or those with broken skins are not suitable for shipment, care must be exercised in picking and packing the fruit. In harvesting, the pickers take the fruit from the tree by hand and place it in baskets or buckets for hauling to the packing house. Light ladders are used for reaching the fruit on the tall branches.

In the packing shed the fruit is very carefully poured into bins on packing tables, where it is sorted to size by hand and defective plums removed as it is placed in the containers for shipment. This sorting requires considerable time, and often much of the bloom which covers the plums is rubbed off, seriously detracting from the appearance of the fruit. A machine for grading plums to size is very much needed by the growers.

For shipping the fruit a crate holding four tin-rimmed veneer baskets is the container in most common use in California, although the lug box and a few other types are used. These are also used in some of the districts farther north. The size of the lug box used in California is fixed by the State fruit and vegetable standardization act, the dimensions being 4 inches deep, 14 inches wide, inside measurements, and 17½ inches long, outside measurement. A container called a "suitcase," which is 3½ inches by 11½ inches, inside measurements, by 19¾ inches, outside measurement, holding about 18 pounds of fruit, is becoming popular. The official standard dimensions in Washington for the suitcase are 3¼ inches by 11½ inches by 18 inches, inside measurements. In using the suitcase the fruit, usually ungraded as to size, is carefully poured in through one of the narrow sides, which is left open for this purpose. It is settled into place by pressing and jarring and then the side is nailed on, ready for shipment.

To pack baskets the sides are first lined with paper and sizes selected which when placed in uniform rows form layers which will tightly fit the basket. When there is a slight unevenness in size, a thin layer of wood veneer is sometimes placed in the box before the last layer of fruit is packed. This holds the fruit in place and prevents displacement in transit, so that it will present a more attractive appearance in the market.

As a rule, each orchard or farm has its own packing house, which is conveniently situated in or near the orchard where the fruit is packed and loaded on trucks for transporting to the shipping station.

Laws regarding the size and quality of fresh fruit and the shipping containers are operative in each of the Pacific States and enforced by county, district, or State officials.

The prune harvest is more cheaply and quickly accomplished and with less care than is the plum harvest. The fruit is allowed to remain on the tree until it is thoroughly ripe and is falling of its own accord. Where jarring is necessary to cause the fruit to fall, it is done by striking the branches with poles. The fruit is gathered by hand from the ground or canvas on which it falls and is placed in lug boxes for hauling to the drying yard.

Owing to natural humidity and fall rains, the entire output of prunes in Washington, Oregon, and Idaho must be dried artificially.

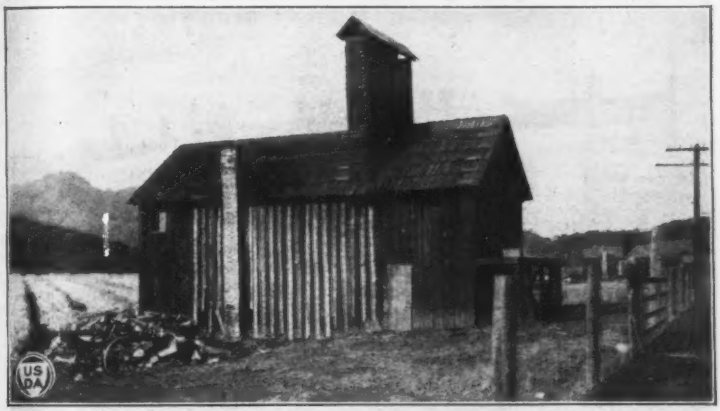

FIG. 32.—A 3-tunnel drier typical of those used by many prune growers in the Northwestern States.

In California the period during which prunes are dried is usually hot and dry, and almost the entire output is cured in the sun. (Figs. 32, 33, and 34.) During recent years artificial evaporation has come into considerable prominence here as an insurance against the loss of fruit from rain. This method of drying is more expensive than open-air drying, but in case of early fall rains it enables the grower to dry his crop without the loss of fruit. After drying, the fruit is taken to the processor, where it is prepared for market.

Those interested in the details of prune drying should consult Department of Agriculture Bulletin 1141, Evaporation of Fruits.

DISEASES AND INSECTS.

A number of diseases and insects attack the plum and prune in the Pacific States. They are amenable to control or preventive measures, with which the grower should become familiar in anticipation of having eventually to make use of them.

The principal diseases include brown-rot, which causes decay of the fruit and may affect the small twigs and spurs, or even the blossoms; leaf-spot and shot-hole fungus, which attack the leaves; and heart-rot and oak-root fungus, which attack the tree. Other diseases may occur, but those mentioned are usually the most common.

The diseases affecting the fruit and foliage are held in check by spraying; those affecting the woody parts of the tree are subject to preventive methods only.

Heart-rot is a rather general term commonly applied to the results of wood-decaying organisms which find entrance to the heart of the tree through long stubs left in pruning, bad crotches or pockets resulting from improperly formed tree tops, or wounds made in other ways. Preventive measures consist obviously in avoiding or eliminating those means through which the fungi causing decay enter the tree.

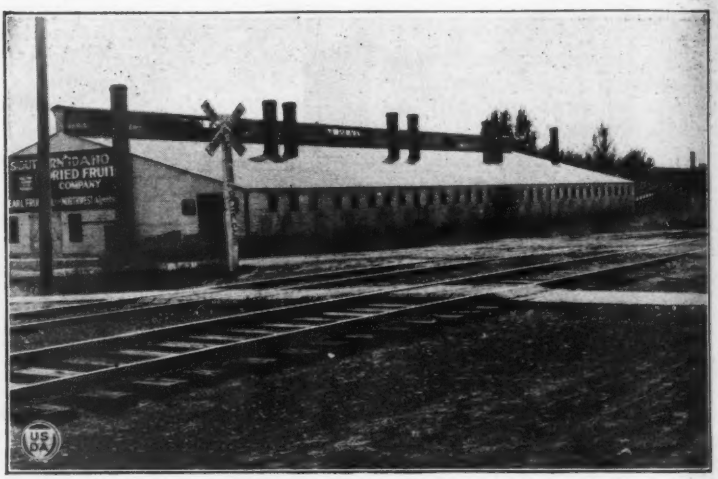

FIG. 33.—A modern large-capacity prune drier and processing house combined. (Idaho, 1921.)

Oak-root fungus is common on roots of oaks indigenous to some of the fruit districts of the Pacific States. The roots of many fruit trees are likewise susceptible to this disease. Where it occurs the only practicable course is to leave the infected areas unplanted or to plant pears propagated on French roots or figs (where these fruits are adapted), since these are about the only fruits resistant to this disease. California black walnuts are sometimes planted in such instances, to be top-worked later to the Persian walnuts.

Among the most destructive insects which attack plums and prunes in the Pacific States are the peach-tree borer, San José scale, red spider, thrips, twig-borer, brown apricot scale, and black scale. These, with a few of less general importance, cause heavy losses annually to the plum and prune producing industry.

As climatic and other conditions vary greatly in different regions and localities, the plum grower should apply to his State agricul-

tural experiment station for advice regarding preventive and remedial measures to be employed for the control of injurious insects

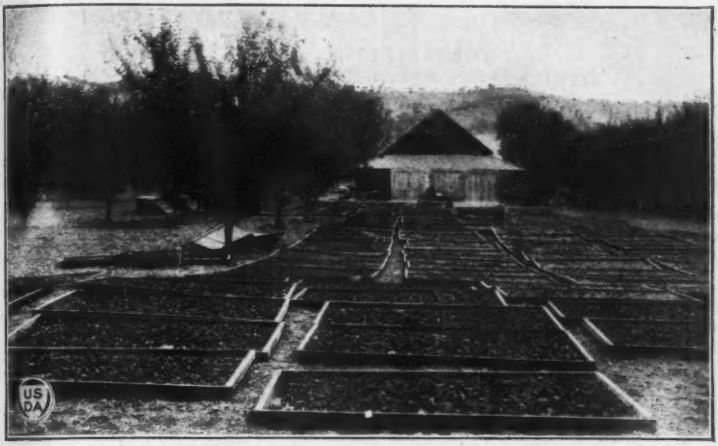

FIG. 34.—A prune-drying yard in central California. (September, 1921.)

and diseases with which he is likely to have to contend. Information may also be obtained from the United States Department of Agriculture.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

August 14, 1924

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Rev. Aug. 1931

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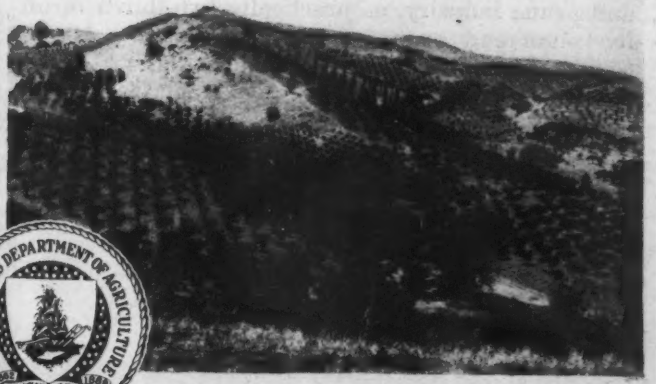
PLUM and PRUNE GROWING in the PACIFIC STATES



IN ITS VARIOUS FORMS the plum is more widely distributed throughout the country than any other tree fruit, though in value the plum crop is exceeded by that of four other fruits—the apple, peach, orange, and grape. The great range of distribution, however, is mainly incident to the great diversity that occurs in the species of native wild plums, cultivated horticultural varieties of which are found in almost every nook and corner of the country.

Though the native plums give vastness in range of plum culture in general, it is the domestica or European varieties, the Japanese sorts, and those that have originated as hybrids between Japanese and native plums that constitute the commercial industry. Prunes are included in the domestica or European group. Some of the Japanese and hybrid varieties are grown very widely, possibly as widely as the varieties of any one species of native plum.

Though this bulletin is regional in its direct application, it has to do with a very large part of the plum and prune industry, as practically two-thirds of all the plum and prune trees in the country are in California, Oregon, Washington, and Idaho.

Washington, D. C.

Issued August, 1924
Revised August, 1931

PLUM AND PRUNE GROWING IN THE PACIFIC STATES[1]

By C. F. KINMAN, *Pomologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page		Page
Plum and prune growing regions	1	Top-working	27
Central California valleys lying west of the Coast Range	3	Distance for planting	31
Interior valleys of central California	4	Nursery trees for planting	31
Western Oregon and western Washington	7	Time for planting	34
Eastern Oregon, eastern Washington, and Idaho	9	Orchard culture	37
Choice of locality and site for a plum orchard	11	Irrigation	39
Varieties	18	Cover crops	43
Varieties of plums and prunes in the Pacific States	20	Intercrops	46
Pollination	24	Pruning	46
Stocks used in propagating plum trees	25	Fruit thinning	52
		Propping and bracing	53
		Fertilizers	53
		Fruit harvest	53
		Diseases and insects	56

PLUM AND PRUNE GROWING REGIONS

THE AREA which may be utilized for the culture of plums and prunes in the Pacific States is very much limited when compared with the gross area of these States, as orcharding is restricted to tillable lands which are under irrigation or to locations where the winter rainfall is sufficient for the needs of the trees.

These requirements have resulted in limiting the commercial growing of this crop to certain sections, although in those sections plums and prunes are among the most important fruits produced. These sections, widely separated in distance and in climatic conditions, are discussed here separately as far as possible. Natural geographical

[1] In this bulletin the plum and prune are considered one fruit, and botanically the European or domestica plum and the prune belong to the same species, *Prunus domestica*. The cultural methods are the same, but the methods of harvesting and handling the fruit are or may be different, depending on the use to which the fruit is put. The use of the terms "plum" and "prune" dates back for several centuries. The words come from different sources, one being Anglo-Saxon, the other French. Originally they doubtless were synonymous in meaning. At what date the term "prune" was first used to designate a "dried plum" or a plum capable of being dried into a product having certain desirable characteristics is uncertain; however, this term has come to signify a plum which is capable of being dried without fermenting when the pit is not removed. The term also signifies the dried as well as the fresh fruit. A prune, therefore, is substantially a variety of plum which possesses certain peculiar characteristics. Most plums, if dried with the pits remaining in them, would ferment in the process. Prunes, in the fresh state as compared with plums, usually possess a firmer, drier flesh, a higher content of sugar, frequently a higher acid content, and are liable to be rather astringent until very ripe; in other words, a prune is a plum having these characters in a more marked degree than other plum varieties. Large quantities of fruit which could be dried to prunes are sold in the fresh state; they are then handled in identically the same way that plums are handled. Plums are sometimes dried after the pits are removed, but the product is called "dried plums," not "prunes." In case of varieties that can be dried to prunes, the fruit in the fresh state, as indicated above, is often called a prune; and in some instances the word "prune" is a part of the variety name, as the Italian prune or German prune.

XUM

divisions are used for boundaries of the regions where phases of the industry, such as marketing and cultural methods, differ sufficiently to warrant separate consideration.

The boundary of each of these regions to which some phase of the industry is peculiar is determined largely by prevailing temperatures, although, within a given region, soil conditions and the availability of water for irrigation result in considerable divergence in methods of carrying out details in orchard management. Although this crop (plums and prunes considered collectively) may be found in home orchards of all sections of the Pacific States, four geographical districts may be said to include the principal commercial producing areas of this fruit. These are (1) the central California valleys lying between the Coast Range of mountains and the Pacific Ocean, including the Santa Clara, Napa, and Sonoma Valleys and their tributary valleys and adjacent foothills; (2) the interior valleys of central California, including the Sacramento, San Joaquin, and tributary valleys, and the bordering slopes and foothills; (3) the principal river valleys and the adjacent rolling lands of western Oregon and western Washington, including the Willamette, Columbia, and Umpqua River valleys; and (4) the irrigated valleys of southeastern Washington, northeastern Oregon, and the Snake River valley region of Idaho. With this last section is included also the region of east-central Washington and the bordering portion of Idaho known as the Palouse region, which lies in the same geographical district as southeastern Washington, although cultural practices differ decidedly in the two sections.

Plums are grown commercially also in southern California, principally in Los Angeles and Riverside Counties, but here they are not among the more important fruit crops. In the four divisions specified there is produced almost the entire commercial output of plums and prunes in the Pacific States, although the plum is widely planted for home use, and a large list of varieties is represented in the home orchard in all fruit-growing localities of these States.

In each of the four main districts some phase of plum culture is practiced which is for the most part distinct from that of the other districts, these differences being made necessary by the peculiar climatic conditions of the district. The main features in the culture of this crop which are peculiar to each district may be summarized as follows:

(1) The valleys of central California west of the Coast Range include the principal centers in this country for the production of the Agen, commonly called the French prune or Petite prune, and of the Imperial Epineuse prune. In this district these varieties are grown in far greater quantity than all other varieties combined, and owing to the warm, dry fall climate the crop of prunes may in most seasons be dried in the open air. The larger portion of the orchards in this district is under irrigation.

(2) The interior valleys of California produce plums both for shipping fresh and for making into prunes. Practically all the varieties of plums and prunes grown in the Western States are represented here. Almost the entire acreage in this district is under irrigation.

(3) In western Washington and western Oregon the Italian prune and the Agen are the only varieties of wide commercial importance among the rather small list grown, the Italian prune being decidedly the more important of the two. The entire output of prunes is dried by artificial means. Practically all orchards of this district are grown without irrigation.

(4) In the district east of the Sierra Nevada Mountains, including southeastern Washington, northeastern Oregon, and Idaho, the Italian prune is by far the most important variety, almost the total crop being shipped fresh to distant markets. The entire acreage in this district is under irrigation except in the Palouse region, where the Italian prune is the only commercial variety and all orchards are maintained by dry-farming methods. The fruit in the Palouse region is usually dried into prunes and by artificial means, but some fresh fruit is shipped to distant markets.

For convenience in describing the commercial distribution, the prevailing cultural practices, and the economic conditions in plum culture, the districts above mentioned are considered separately.

CENTRAL CALIFORNIA VALLEYS LYING WEST OF THE COAST RANGE

The first district includes the cultivated areas of the Santa Clara, Sonoma, and Napa Valleys and their tributaries, or the valley areas

FIGURE 1.—Orchard of Agen (*French prune*) prunes growing in a fertile valley soil. (Healdsburg, Calif.)

of Santa Clara, San Mateo, San Benito, Sonoma, and Napa Counties. Varieties for prune making are grown throughout these valleys and to some extent throughout the adjacent lower slopes and foothills, with centers of production near San Jose, Napa, and Healdsburg. But few plums for the fresh market are grown here, and some are grown for canning. (Fig. 1.)

Since 1875 plum growing in this district has been gradually increasing, except for a few interruptions due to low prices of the product. It is now the principal industry, and the large area of trees not of bearing age, equaling almost half the present bearing area, indicates the present rapid expansion of the industry.

The Santa Clara Valley, the first center of the prune industry in this country, is still the principal center of production, with more than half the prune trees in the district, mostly in Santa Clara

County. Nearly one-fourth of the prune trees in this district are in Sonoma County.

The soils devoted to plum and prune production in these valleys are, for the most part, the deep fertile loams and sandy loams which are darkened by a moderate humus content and are easily handled, productive, well drained, and enduring in nature. Small areas of adobe soil are found, and in certain sections the soil moisture becomes excessive in some years, requiring drainage for the most satisfactory tree development. The summers are long and warm, and, as in all fruit-growing sections of the Pacific States, the summer rainfall is exceedingly light and is disregarded through the plum-growing season. Irrigation is practiced wherever water is available and facilities for its application have been provided. During the period for drying fruit, in September and early October, occasional interruptions are caused by rains, which make it necessary to stack the drying trays, and even with this precaution the loss of fruit is not always avoided and is sometimes considerable. With ordinary caution, however, in most years the crop may be dried in the open with but little, if any, loss. As an insurance against damage by rains a number of artificial driers have been erected, and about one-fourth of the crop is now dried by them. The temperature throughout the prune-growing sections of this district is very much the same through the fruit-growing season, except that the daily range is somewhat greater during the warmest part of the summer in the portions of the main valleys which are farthest from San Francisco Bay.

Aside from the Agen, which is the principal variety in all sections of this district, the Imperial Epineuse is grown to a considerable extent in the Sonoma Valley, especially in the plateaus bordering the valleys near Healdsburg. Throughout the district the Sugar and the Standard are varieties of some importance. The culture of plums for shipping fresh is not an important industry here, mainly owing to insufficient warmth during the early summer to ripen them so that they may be marketed in competition with the plums from sections where they ripen earlier. In some localities of this district there is also a lack of water for irrigation, which is needed to produce fruit of the larger sizes suitable for shipping. A few orchards are maintained to supply plums for canning.

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

The interior-valley district includes the Sacramento and San Joaquin Valleys of California and their bordering slopes and tributary valleys. Plantings which total more than 5,000,000 trees are found in all localities of this district where plums and prunes are cultivated, with three-fourths of the plantings in the Sacramento Valley. The largest centers of production are the Loomis-Auburn section of Placer County, the vicinity of Vacaville in Solano County, the Hood-Walnut Grove section of Sacramento County, in Tulare County, along the Feather River in Sutter County, and near Chico in Butte County. One-third of the plum trees in this district are in the first two sections mentioned. Fresno and San Joaquin Counties also have a large acreage devoted to this fruit, and all other counties of the district include it among their fruit crops.

The plums which ripen first in the Pacific States are produced in the large plum-growing sections of this district where there are extensive plantings of early-maturing varieties. The first harvests are made in the foothills of Solano County, near Vacaville, where fruit of the earliest varieties is shipped to eastern markets during the last of May. The harvest in the valley near these foothills and in the foothills of Placer County starts but a few days later and is followed closely by that in the sections through the main valleys.

While the low winter temperatures are approximately the same throughout the district, the localities where the earliest fruit is produced are naturally protected in the spring from the cool, moist breezes which sweep through the main portions of the lower valleys, and their surface soils are well drained, friable, and absorb heat well. These conditions result in the early blossoming of the trees and the rapid development of the fruit.

Plums both for fresh shipment and for prune making are grown extensively in all the fruit-growing centers of the district except in

FIGURE 2.—A plum orchard on delta land in the lower Sacramento Valley, Calif. Note the close planting and vigorous growth of the trees. A small portion of the river levee is shown at the left

Placer County, where the entire output is fresh fruit, and in the Hood-Walnut Grove section, where almost the entire output is fresh fruit. In the latter section small plantings of canning fruit are maintained. Aside from these localities, which are the most important sections in California for the production of plums for fresh shipment, the Vacaville section is the center of heaviest production. Two-fifths of the plum trees of this district are still under bearing age. Vast areas suitable for this fruit are now occupied by annual crops or are not under cultivation, a result largely of the lack of irrigation systems.

The soils devoted to plum culture in this district are those of the deep, fertile, alluvial types in the valley bottoms. (Fig. 2.) In the higher lands there is a wide range of type varying from heavy deep loams to sandy and gravelly soils, where the underlying stone is sometimes covered with only a shallow layer of tillable earth. Soils underlaid near the surface by hardpan, which occupy broad areas in the main valleys, are avoided almost entirely for varieties for prune making and are naturally unsuited to varieties for fresh shipment. Soils derived from granite and some types of sandstone, such as are

XUM

sometimes found in the rolling foothills bordering the large valleys, are in demand even where the stratum of tillable soil is not deep.

Notable among the nonirrigated sections is the rolling area near Vacaville, in Solano County (fig. 3), where the foothill soils are derived from and underlain with sandstone. If properly tilled, these soils are sufficiently retentive of moisture to produce profitable crops of fruit without irrigation. As no water is available for irrigation in this section, dry-farming methods are practiced, and the earliest ripening fruit is grown.

In this district the summers are long, hot, dry, and well suited to the early ripening of plums as well as for the satisfactory development of prunes. As a rule, the summer drought continues well into the autumn, so that prunes may be dried in the sun without loss from fall rains. However, the fear of damage by fall rains has

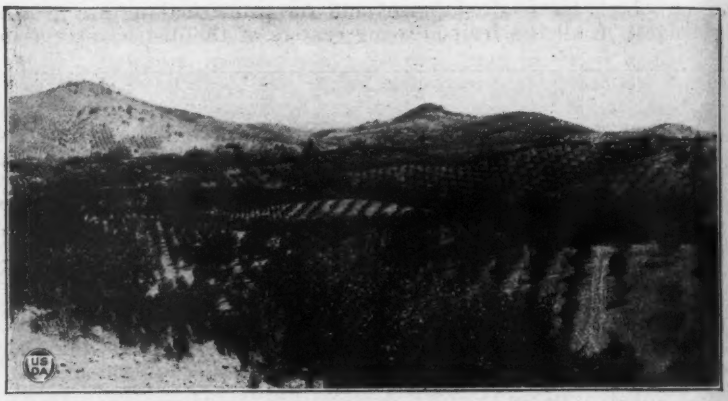


FIGURE 3.—Plum orchards on the rolling lands near Vacaville, Calif., in July, 1921. The season's earliest fresh-fruit shipments to eastern markets are made from orchards on these lands

resulted in the construction of dehydrators which now care for the drying of a part of the crop. The early warmth in the spring causes the trees to blossom early, and some injury by frost, at least to the early blooming varieties, is not uncommon in the lowlands. Here the annual rainfall varies considerably from year to year, but there are no rains during the fruit-growing season. Irrigation is therefore imperative in the shallower soils and highly desirable on the deeper valley soils not moistened by subirrigation. In some places in the Hood-Walnut Grove section of the lower Sacramento Valley, orchards are usually plentifully supplied with moisture by subirrigation.

As in the valleys near the coast which were just discussed, the Agen variety is by far the most important for prune making, although orchards of the Imperial Epineuse, Standard, Sugar, and Sergeant (*Robe de Sergeant*) are occasionally found. Almost all varieties of plums grown commercially in the Pacific States for fresh shipment are found here in considerable quantities.

WESTERN OREGON AND WESTERN WASHINGTON

The principal commercial plum-growing centers of western Oregon and western Washington lie in the cultivated areas between the Cascade and Coast Ranges in western Oregon and west of the Cascade Mountains and the Puget Sound region of Washington. Until the late eighties plum growing was a minor industry in this district, but about that time it became popular and most of the older orchards were established. Plantings were not greatly increased until the past decade, when many orchards were established or old ones enlarged.

The principal regions where plums are found are in the vicinity of the Willamette River in Polk, Marion, and Yamhill Counties, with centers near Salem, Dallas, and Newberg, and in the Roseburg-Riddle section of the Umpqua River Valley in Douglas County, where the

FIGURE 4.—A prune orchard in bloom in a rather narrow valley location. (Umpqua Valley, Douglas County, Oreg.)

plantings are about the same in extent as in the different counties farther north just mentioned. More than three-fourths of the prune trees in western Oregon are in these four counties.

In western Washington the principal plum-producing region is the Vancouver-Camas-Washougal section of Clark County.

The greater portion of the orchards in the Umpqua Valley are in the bottom lands near the river, while in the Willamette River Valley region the rolling lands have been as much favored as the low valleys for prune production. (Fig. 4.) Many growers have given preference to the broken, rolling lands which reach 500 or more feet above the river bottom. (Fig. 5.) In the prune-producing sections of Washington just mentioned, both the flat lands near the Columbia River and the rolling lands extending back several miles from it and in the Puget Sound region are used.

Many soil types are represented in the orchards of this district. Through the sections in Oregon brownish or reddish clay loams predominate, with subsoil heavier in texture but of the same material,

which has been derived from the basalt rock with which it is underlain. In the lower valleys, notably that of the Willamette River, the humus content is rather high and the soil is loosened and darkened by it. This soil is deep and retentive of moisture. Through the red and brown soils of the rolling orchard sections the humus content is low, and the surface soil dries out rather quickly and is sticky when wet. When cultivated while too wet it forms compact clods, which are very hard when dry, but if tilled when in proper condition it works up into a light loam of excellent quality.

The surface soils in the plum-growing sections of southwestern Washington are, for the most part, sandy or gravelly loams, light brown, brown, and gray in color, underlain at a varying depth of about 3 feet and over with a deep stratum of very coarse gravel. This soil is easily tilled but not retentive of moisture because of the excellent subdrainage. In the prune-producing sections farther

FIGURE 5.—A typical site of a prune orchard in the broken rolling section of northwestern Oregon

back from the Columbia River the subsoils are finer in texture and more compact, and therefore more retentive of moisture. Soils built up by washings from the Columbia River and similar soils of the rolling section to the northeast of Vancouver Lake in Clark County, Wash., are deep, fertile, fairly retentive of moisture, and are prized for prune production. (Fig. 6.)

In this district the rainfall is heavy during the fall, winter, and early spring, but drought prevails during the summer, the same as in most cultivated areas of the Pacific States. Almost no irrigation is practiced in this district, although the need for moisture is apparent during the late summer throughout most of the large orcharding areas, especially in rolling sections where the humus content is low and in places where the substratum of coarse gravel comes to within a few feet of the surface. There is some variation in the length of the dry season in different years. The rains sometimes start while the prune harvest is in progress and occasionally continue in the spring until the trees are in blossom. Injury to the crop results in either case.

Low temperatures have caused serious injury to the trees in northwestern Oregon and southwestern Washington, at least in the lowlands. The summers in this district are warm, but several degrees cooler than in the central California valleys and somewhat cooler than in the plum-growing centers of the valleys of California near the coast or of those of eastern Washington, eastern Oregon, and Idaho.

No plums are shipped fresh to the eastern markets from this district because of the moist atmosphere at harvest time, with the resulting prevalence of brown rot. A few are grown for the local markets and for canning, but almost the entire crop is dried into

FIGURE 6.—A comparatively old orchard of the Italian prune in Clark County, Wash., near Vancouver. Trees planted 20 by 20 feet. The orchard has been well fertilized and tilled and produces well

prunes. The total output of prunes is cured artificially, owing to the moist fall weather, which makes open-air curing impracticable.

The planting of plums has been confined largely to the Italian prune variety, although a number of orchards of the Agen (or the Petite prune, as it is commonly called in the Northwestern States) are found. The proportion of the Agen prune is greater in Oregon than in Washington, especially in Douglas County, where, in the Myrtle Creek-Riddle section, it is grown almost to the exclusion of other varieties. There are a few orchards of Sugar, Imperial Epineuse, and Standard prunes, but the output of these varieties is not important at present.

EASTERN OREGON, EASTERN WASHINGTON, AND IDAHO

The planting of commercial orchards of plums in the district embracing eastern Oregon, eastern Washington, and Idaho has been confined almost entirely to the irrigated valleys, with important

centers of production near Walla Walla, Wash.; the Milton-Freewater section of Walla Walla County, Wash.; in Umatilla County, Oreg.; the Yakima Valley in Yakima County, Wash.; and the Weiser-Emmett-Boise section in southwestern Idaho. Prunes are grown commercially, but not very extensively, in northern Wasco County, Oreg., near The Dalles; in eastern Whitman and southeastern Spokane Counties, Wash., and the bordering portion of Idaho, known as the Palouse region. There is no water available for irrigation in the last two sections, but orchards are maintained by dry-farming methods. Since the early nineties, when the major portion of the oldest plum orchards of this district were established, the growth of the industry has been slow until within the last 15 years, when extensive plantings were made. The Walla Walla, Milton-Freewater, and Yakima sections are centers where extensive new plantings were made during and following the World War. The increase is less marked in the fruit-growing portions of Idaho.

The soil in which fruit is grown in this district is, for the most part, a fertile, friable, easily tilled sandy loam of varying depth and organic content. It is everywhere sufficiently deep for good tree growth, and in some places, notably in the Yakima Valley, it is exceedingly deep. The surface soils are open and well drained, and the subsoils in most places are composed of stratified materials and are well drained also.

The sections from which plums are shipped from this district are semiarid to arid in nature. The summers are somewhat shorter than in the plum-growing sections of western Washington, western Oregon, and California, and the days are hotter than in western Oregon and western Washington, with the daily range of temperature greater. The rainfall is light, nearly all of it occurring from September to April. The total precipitation is considerably less than in the other districts described, except in the Palouse region, where practically all the plums are shipped fresh. The fruit reaches good size and, owing to dry weather which usually prevails at harvest time, may be successfully shipped to distant markets.

In the Palouse region, where the prevailing summer temperatures are low, the rainfall light, and only moderate cultivation is given, the fruit is usually below the sizes sent to the market fresh. A portion of the fruit from this region is shipped fresh when the prices for fresh fruit are high or the fruit for the season is above the average in size.

As in the sections farther west, the Italian prune is by far the most widely used variety for commercial plantings. A considerable number of orchards of Pond and Tragedy are found, also occasional plantings of Reine Claude (*Green Gage*), Peach, Tennant, and a few other varieties. The greatest acreage of varieties other than the Italian prune is found in the Yakima and Walla Walla sections. An occasional orchard of Agen is found in these sections and in the Boise, Idaho, section. All of these commercially grown varieties are of the *Prunus domestica* group. Japanese varieties or Japanese-American hybrids have been planted in an experimental way only. The new plantings of these little-grown varieties are very few. The fruit of the Tragedy variety develops well here, but has not been a

consistent cropper. Trees of the Pond have been prolific, and the variety is considered profitable.

The harvest of the Italian prune for fresh shipment in this district starts about August 10 in the section near The Dalles, Oreg., and is followed in a week or so by that from the main irrigated centers. In the Palouse region the fruit ripens late and is allowed to remain on the tree until the growing season ends and sometimes until after sharp frosts have occurred, when it falls or is easily shaken to the ground and is gathered for artificial drying.

In case of an unsatisfactory market for fresh fruit or if the fruit is small in size, a part of the crop is dried in all the main plum-growing centers of this district. All fruit for drying is processed by artificial means, the work often being done in central desiccating plants rather than in the small individual orchard driers.

CHOICE OF LOCALITY AND SITE FOR A PLUM ORCHARD

The plum is adapted to a wide range of soil and climatic conditions and is found in all sections where fruits are grown in the Pacific States. Prevailing temperatures in fruit-growing sections of this region are for the most part suited to commercial plum culture, though the rainfall is sparse during the summer, irrigation being necessary in some localities. After the establishment of means of transportation through rural districts to central markets and the providing of means for irrigation, some points which require consideration are the selection of the proper soil type, the contour suitable for orcharding, and the locality where temperatures are congenial to the development of the variety the orchardist wishes to plant. Varieties grown for early fresh-fruit shipment are usually not types which sell well in the market with later maturing varieties and therefore should be planted where natural conditions favor their early ripening. Also, varieties grown for their dried product must be planted in places having a long growing season. Where fruit is for fresh shipment, not only the size of fruit must be considered but also the possibility of loss from brown rot. The climate must be sufficiently free from moisture at harvest time to insure the fruit arriving in market without loss from decay in transit. The choice of a location and site for an orchard is then largely dependent upon the particular market in which the grower wishes to sell his product.

SOILS

Plums are not particularly sensitive as to soil, provided it is reasonably deep and fertile. They are found growing on a great number of soil types. The Japanese or American-Japanese hybrids, which make up a large acreage of plums grown for fresh-fruit shipment in California, will succeed on a soil more shallow and somewhat thinner than varieties of the *Prunus domestica* group, especially those which are grown for prune making. For the latter, only deep, fertile, well-drained land should be used, the heavier clay loams being preferable to the sandy loams. Soils which are underlain near the surface with hardpan should be avoided for plum culture.

XUM

Plum plantings for the most part have been made on soils derived from volcanic materials which have been laid down by sedimentation through the irrigated sections of Idaho, Washington, and Oregon; on the residual reddish clay loams and dark valley soils which have been filled in by washings from this type in western Washington and western Oregon; while in California, where the culture of this fruit has been greatly diversified, many different soils are used. However, for the production of prunes plantings here are confined almost entirely to the deep, dark, heavy loams such as are preferred by pear growers and which have been washed into the valleys from the surrounding hills. All varieties of plums for fresh-fruit shipment are grown in the valleys as well as on more upland soil, while those grown for their dried fruit are seldom planted on the more shallow uplands, where early shipping plums do well and have been extensively planted. For plums for fresh shipment, the more shallow, upland soils are not used except under irrigation or unless the soil type is such that it is very retentive of moisture, since a liberal supply of soil moisture is essential to the development of the large sizes demanded by the market for early plums. Notable among non-irrigated, rolling lands where plums for fresh shipment are grown is the rolling, hilly country lying in the immediate vicinity of Vacaville, Calif. Here the friable sandy loam, which is residual in origin, is well drained and open and warms quickly in the spring, and the subsoil and underlying sandstone, from which the soil has come through disintegration, is retentive of moisture, making natural conditions highly suited to the early ripening of fruit. In this region the summers are hot and dry, but the soil moisture is sufficient to bring a moderate crop of fruit to a desirable marketable size. Under these conditions the crop ripens several days earlier than in the immediately adjoining lower valley, where the deep fertile soil is more compact and slower in warming up in the spring. On the thinner soils of the hills, however, the tree growth is less than in the valley, and the crops are not so heavy as in the deeper soil.

Placer County, Calif., is situated on the western slope of the Sierra Nevada foothills, where the soil as a rule is not deep and is low in organic matter, but is open, friable, well drained, and under good cultural methods retentive of moisture. It is derived by the weathering of granite bedrock and is a sandy, gravelly loam, varying considerably in depth. Outcroppings of granite occur occasionally through the orchards, while good soil to the depth of 6 feet or more is commonly found. While plum growing is extensive in each of the localities just described, varieties for prune making have been planted very sparingly.

In the deep fertile alluvial soils along the river in the lower portion of the Sacramento Valley plums for both fresh shipment and drying for prunes are grown side by side with equal success. (Fig. 7.) Here the climatic factor is the one which influences the planter most in his choice of crops. In the interior valleys, where the climatic and marketing conditions are suitable, both plums and prunes are widely grown. On soils of the same general nature in the valleys near the coast climatic conditions cause a later harvest of plums for fresh shipment, and as a result they are but sparingly planted. Here prune production is the most extensive phase of fruit culture.

The principal soils used for plums in western Washington and western Oregon are the deep, enduring types, of both residual and sedimentary origin. In these soils the organic content is low except in the river bottoms, and when dry the soil is hard and difficult to cultivate. In a few smaller centers the soils are shallow, inclined to be heavy, and not conducive to a large tree growth or regular production of good crops. In the eastern part of these States and in Idaho, orchards are found mostly in the deep sandy loams of sedimentary origin where the settling of volcanic material has been an important factor in the formation of the surface soil, as in the Yakima Valley of Washington. These grayish mellow soils are easily tilled, very fertile, and fairly retentive of moisture when well

FIGURE 7.—An old orchard of the German prune on fertile river valley soil. The spread of the tree in the foreground is 34 feet. These trees were originally spaced 20 feet each way. The diagonal rows of trees have been removed and pear trees, which are more upright in their habit of growth, are planted in their places

cultivated. Where they are of sufficient depth they are suited to plum and prune production, as both good size and a development that insures a good dried product are obtained.

Strata of hard, compact material or hardpan are often found within a foot or two of the surface in some types of sedimentary soils. The grayish open surface soil in such places is usually fertile if an excess of alkali is not present, but the greatest care and judgment should be used in selecting a site in such soils. In regions where a hard stratum of subsoil appears there is danger of selecting a site where the soil is of so little depth that it will become waterlogged by the settling of the moisture into the low places in the hardpan. Or one may find a soil which does not provide sufficient depth for normal root growth for plum trees. When planted on fertile shallow soils underlain with hardpan, trees often grow well for a few years and produce fairly well while young, but an un-

XUM

profitable crop of fruit or the loss of trees often follows by the time full production should have been reached.

Soils rich in nitrogen may cause a thrifty growth, but those well balanced in available plant foods are necessary for the regular and continued production of large sizes of well-developed fruit. While the size of the fruit for fresh shipment can be regulated to a considerable extent by the manipulation of irrigation water, fertile soils are necessary also for the proper growth and development of fruit. Excessive irrigation often causes poor tree and fruit development, and planting on poor soil results in a crop of small fruit which will prove unprofitable, since within the variety prunes are classified almost entirely as to size when placed on the market.

CLIMATIC CONDITIONS

The plum will thrive where winters are cold and will withstand hot summers, drought, and heavy rainfall as well as or perhaps better than other common deciduous fruits. Frequent and sometimes heavy losses are sustained in some localities, however, from injury to the blossoms by late spring frosts. Some varieties of the Japanese group in common cultivation blossom early in the spring, often several days or weeks before the last frost occurs, while the varieties of the domestica group, usually blooming considerably later, are seldom injured by frost. Practically all sections of the Pacific States where plums are grown commercially are visited occasionally by late frosts, although small areas of somewhat elevated rolling lands are considered to be free from any considerable loss from them. While the plum tree will withstand a heavy rainfall, rainy and foggy weather during blossoming time hinders pollination, and rains during harvest favor the growth of fungi, causing the fruit to decay and therefore seriously hindering both fresh-fruit shipments and prune making. For both long-distance shipment of fresh fruit and for drying, which are the principal objects of plum growing in the Pacific States, the long, dry, hot summers which prevail are well suited.

In western Oregon and western Washington fall rains and high humidity at harvest time make it necessary to dry fruit artificially. Dry fall weather usually permits open-air drying in California, although serious damage to the drying crop has resulted from rain. In the Palouse region of eastern Washington and western Idaho, where the prevailing temperatures are much lower than in other plum-growing centers of the Western States, the fruit develops slowly and usually is left on the trees until frost occurs in the fall, as it is claimed to be difficult to shake the fruit from the trees before that time. After one or two killing frosts it is shaken down easily.

Summer rainfall is exceedingly light throughout the fruit-growing sections of the Pacific Coast States, but the differences in temperature between the fruit-growing sections of these States is sufficient to cause wide differences in the practices followed in orchard management. For the most profitable production of early plums of Japanese and American-Japanese hybrid varieties, the fruit should be shipped before the later ripening varieties of the domestica group, which in the earliest plum-ripening sections of California is midsummer. This is possible only where the spring and summer are warm, as the later

ripening varieties mature under such conditions before the earlier ripening ones in cooler regions. For this reason the cultivation of early-ripening plums has been largely confined to the hot interior valleys of California.

The mean spring and summer temperatures of a plum section largely determine the type of plum growing carried on there. For example, fruit for fresh shipment is largely grown in the hot interior valleys, as compared with the cooler Santa Clara, Sonoma, and Napa Valleys in California, where fruit for drying into prunes is principally produced. In the cooler valleys of California the Agen prune is the principal one grown, while in the Northwestern States, where still lower mean temperatures prevail, the Italian prune, planted only sparingly in California, is grown almost exclusively. However, in a few places in the warmer sections of these States the Agen and other varieties of the domestica group are cultivated to a considerable extent. Temperatures of the principal plum-growing sections are given in Table 1, compiled from the records of the Weather Bureau.[2]

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*

[Data (in degrees F.) for representative plum and prune producing sections of each district, from the summaries of climatological data for the United States by sections for the different stations, as follows: *A*, Section 14, central and southern California, p. 22–24; *B*, section 16, northwestern California, p. 16–17; *C*, section 15, northeastern California, p. 36–37; *D*, section 17, western Oregon, p. 18–19; *E*, section 19, western Washington, p. 9; *F*, section 20, eastern Washington, p. 10; *G*, section 22, southern Idaho, p. 5]

CENTRAL CALIFORNIA COAST DISTRICT

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
San Jose (*A*)	Maximum	63.8	69.9	72.3	76.9	80.9	79.9	79.3
	Minimum	43.7	44.4	45.8	48.7	52.0	51.2	50.0
	Mean	53.7	56.7	60.7	65.0	66.9	66.7	64.7
Hollister (*A*)	Maximum	64.4	69.2	71.5	77.2	81.2	79.8	79.1
	Minimum	40.6	41.5	43.8	46.8	48.7	49.2	47.5
	Mean	54.5	58.2	62.3	65.9	67.2	66.7	65.6
Napa (*B*)	Maximum	63.0	68.8	72.9	79.0	81.2	80.5	80.8
	Minimum	42.1	43.8	47.1	50.5	52.8	52.1	50.1
	Mean	52.6	56.8	60.8	65.4	67.6	67.0	66.0
Healdsburg (*B*)	Maximum	67.1	73.5	77.2	83.8	89.4	87.7	85.6
	Minimum	40.5	43.3	46.2	49.4	50.8	49.3	47.7
	Mean	52.1	56.9	59.9	65.9	68.5	66.5	65.7

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

Tulare (*C*)	Maximum	69.0	77.5	82.4	91.7	99.6	97.2	88.8
	Minimum	40.8	44.5	49.9	56.1	60.2	58.9	52.7
	Mean	55.9	62.6	68.2	77.4	83.0	80.1	71.9
Stockton (*C*)	Maximum	60.9	67.9	73.5	82.7	88.5	86.5	81.8
	Minimum	43.2	46.6	50.0	55.6	57.0	56.5	54.8
	Mean	54.5	58.9	64.1	69.9	72.6	72.5	69.0
Chico (*C*)	Maximum	66.3	73.0	79.9	89.3	98.9	97.4	88.7
	Minimum	41.2	44.8	49.0	55.0	60.2	58.3	53.5
	Mean	55.6	61.6	68.4	77.1	83.9	81.5	74.6

[2] U. S. Department of Agriculture, Weather Bureau, Climatological Division. Summaries of climatological data sections. U. S. Dept. Agr., Weather Bur. Bul. W, vol. 1. 1912.

——— Summary of the climatological data for the United States, by sections. U. S. Dept. Agr., Weather Bur. Reprint [Revision of Bul. W] Sect. 14–17, 19–20. [1912–1918.]

XUM

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*—Continued

INTERIOR VALLEYS OF CENTRAL CALIFORNIA—Continued

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
Auburn (*C*)	Maximum	62.5	69.0	74.7	85.1	91.7	91.8	83.5
	Minimum	42.0	44.7	50.1	55.0	61.1	60.3	54.4
	Mean	51.7	56.5	62.7	70.8	76.8	75.9	71.0
Vacaville (*C*)	Maximum	65.9	71.5	78.5	84.1	93.5	92.1	88.4
	Minimum	42.7	45.4	48.6	51.7	55.8	55.6	52.5
	Mean	53.9	58.8	64.2	71.0	75.5	74.5	70.8

WESTERN OREGON AND WESTERN WASHINGTON

Roseburg, Oreg. (*D*)	Maximum	57.0	62.1	68.0	72.7	81.0	81.2	74.1
	Minimum	38.1	40.1	44.9	48.9	52.6	52.3	47.9
	Mean	47.6	51.4	56.5	60.8	66.9	66.7	61.1
Salem, Oreg. (*D*)	Maximum	55.1	60.9	66.3	72.0	79.6	80.1	72.0
	Minimum	37.9	41.0	45.5	49.7	53.3	53.1	48.7
	Mean	46.2	50.8	55.9	60.9	66.4	66.4	60.3
Vancouver, Wash. (*E*)	Maximum	55.9	62.5	66.8	72.7	79.7	79.5	72.8
	Minimum	37.1	39.7	45.3	49.7	53.2	52.3	47.9
	Mean	45.7	51.6	57.5	62.2	66.9	66.2	60.9

EASTERN WASHINGTON, EASTERN OREGON, AND IDAHO

Walla Walla, Wash. (*F*)	Maximum	54.2	63.5	71.3	77.8	88.2	86.7	75.5
	Minimum	36.8	42.6	48.6	53.7	60.8	60.2	52.3
	Mean	45.5	53.0	59.9	65.8	74.5	73.5	63.9
Moxie, near Yakima, Wash. (*F*)	Maximum	56.5	66.5	74.0	80.9	88.9	87.4	77.3
	Minimum	28.5	34.3	42.0	48.0	53.1	51.1	42.4
	Mean	42.6	50.4	58.2	64.6	71.3	69.5	59.9
Boise, Idaho (*G*)	Mean	44.2	50.1	57.6	66.0	72.8	71.8	61.9

PALOUSE REGION, WASHINGTON

Colfax, Wash. (*F*)	Maximum	50.8	60.0	67.9	73.9	82.8	82.8	72.2
	Minimum	30.0	35.1	40.5	44.6	47.4	46.5	40.4
	Mean	40.4	47.6	54.2	59.3	65.1	64.9	56.3

SUMMARY OF AVERAGES BY DISTRICTS

Maximum:							
Central California coast district	64.6	70.3	73.5	79.2	83.2	81.9	81.2
Interior valleys of central California	64.9	71.8	77.8	86.6	94.4	93.0	85.8
Western Oregon and western Washington	55.7	61.8	67.0	72.5	80.1	80.3	73.0
Yakima and Walla Walla, Wash	53.5	65.0	72.6	79.6	88.5	87.0	76.4
Minimum:							
Central California coast district	41.7	43.2	45.7	48.8	51.1	50.5	48.8
Interior valleys of central California	42.0	45.2	49.5	54.6	58.8	57.9	53.6
Western Oregon and western Washington	37.7	40.2	45.2	47.1	53.0	52.6	48.2
Yakima and Walla Walla, Wash	32.6	38.4	45.3	50.8	57.4	55.6	47.3
Mean:							
Central California coast district	53.2	57.1	60.9	60.5	67.5	66.7	65.5
Interior valleys of central California	54.3	59.6	65.5	73.2	78.3	76.9	71.6
Western Oregon and western Washington	46.5	51.2	56.6	61.3	66.7	66.4	60.4
Yakima and Walla Walla, Wash., and Boise, Idaho	43.4	51.2	58.6	65.5	72.5	71.2	61.9

SITE AND LOCATION

In choosing a site and location for plum growing careful consideration should be given to spring frosts, soil drainage, transportation facilities, and also to irrigation in sections where it is necessary.

If spring frosts are common, rolling or sloping land should be chosen, avoiding the low, flat plains, depressions, and troughs of ravines through which the cold air, like water, flows to lower levels. Even differences of a few feet in elevation often prove of great importance in this respect. (Fig. 8.)

The growth of plum trees on fertile soil washed down through ravines encourages the orchardist to continue plum planting there, but in such locations the planting of fruits which blossom later in the spring would usually result in less loss from frost and no doubt prove more profitable. Orchards occupying the rolling areas bordering the larger fruit-growing valleys, while more difficult to culti-

FIGURE 8.—Sites on a slope where soil and air drainage are better for orchards than in the lower portion of the valley in the distance. (Emmett, Idaho)

vate, are decidedly more nearly free from frost injury to the blossoms than those on the low flat valleys or the high flat table-lands.

Where the soil near lakes of considerable size or ocean bays is suited to cultivation, only little, if any, loss from spring frosts need be feared. In the consideration of sites such places are preferable because the water will temper the hot days of summer as well as protect from the cold in spring. The effect of such a body of water is well illustrated near the border of Lake Vancouver, not far from the city of Vancouver, Wash., where prune production is an important industry and where it is claimed that severe injury to the crop by frosts is unknown. The opposite result in regard to frost naturally obtains along smaller rivers, as here the heavy cold air settles in and follows the course of the water.

Soils which are low, heavy, and in danger of becoming waterlogged during wet seasons or in which surplus water from irrigation collects should also be avoided. While the plum is not so sensitive to an excess of soil water as some fruits, small crops and weak trees

XUM

and often loss of trees follow planting in such places. (Fig. 9.) Only well-drained soils should be selected.

The unquestionable advantage of facilities for irrigation in the regions where irrigation is practiced prove the need of choosing lands where a system is already established or where a water supply sufficient for the type of soil under consideration can be made available. Both prunes and plums are sold largely by their size, and as the soil moisture determines to a great extent the sizes of the fruit the water supply should not be overlooked.

The condition of country roads and the proximity of packing houses and shipping stations need also to be taken into account. While these are not so important where the fruit is to be dried, good smooth roads, preferably free from dust and with packing and shipping facilities close by, are decided advantages to the shipper of fresh plums who must send his product to distant markets.

FIGURE 9.—Prune trees, dead as a result of poor drainage—the fate of trees on low, heavy soil

VARIETIES

The ease with which new strains and varieties may be created by artificial crossing or by the selection of chance seedlings and the patience and intelligence exercised by many western plum growers in testing new types has led to the development of a large and ever-increasing number of varieties. Many of these varieties have been taken into almost every locality where orcharding is not entirely prohibited by natural conditions, and the requirements of varieties with respect to soil, weather peculiarities, and cultural conditions, both natural and artificial, have been determined perhaps more closely than for any other of our cultivated fruits.

Many of the commercial varieties of plums widely planted in the Pacific States were originated or first introduced into cultivation there, and in most instances in central California. Many new varieties of promise are now being introduced to the trade.

In establishing an orchard for the production of plums for the fresh-fruit market, it is the practice to plant a number of varieties which ripen in succession, so that the fruit pickers may go from one variety to another without interruption, thus avoiding the necessity of procuring additional help to harvest the varying number that

ripen at the same time. Where there is a period of a few days between the ripening of varieties in the succession, or if a variety fails to fruit, considerable confusion and perhaps financial loss results from the disorganization of the picking, packing, and hauling crews. This emphasizes the importance of selecting varieties for their regular bearing habits as well as for quality and appearance of fruit and those so suited to the peculiar soil and climatic conditions that they fit into the successive ripening scheme.

Many varieties are partially or entirely self-sterile. When such varieties are planted, other sorts which will pollinize them must also be planted near by. At the same time these pollinizers must possess desirable qualities for commercial planting and likewise fit into the list for successive ripening. With the great number of plum varieties, each with its peculiarities as to growth, production, quality of fruit, and the broad demands of the grower and the market, the choice for planting becomes one of greatest importance to growers. For prune making the conditions to be met are not so numerous as in the production of fruit for fresh shipment. The selection of a variety adapted to the natural local conditions, including soil and climate, is the principal problem. Shortage of labor and the loss of a little time in harvesting, processing, or delivering to local or distant markets cause no such loss or concern to the grower who dries his fruit as to the one who must harvest, pack, and deliver his fruit to the consumer within a relatively short time or else withstand a severe or perhaps total loss of his fruit by spoiling or having his product offered on a market when the price is unsatisfactory.

The expense of picking and packing the fruit, the purchase of shipping containers, and the cost of icing and transportation to the distant market is relatively considerably higher for the fresh fruit than for the dried product. Owing to these expenses the hazards in the production of fresh fruit are considered by many to be greater than for prunes, although the high market price for fresh fruit makes its culture desirable if natural conditions are favorable to the development of large fruit of good quality. A large number of varieties are under cultivation for the production of both fresh and dried fruit, although the diversity required for the profitable growing of fresh shipping plums has led to the planting of a much greater number of varieties for this purpose than for prune production.

The dates of blooming as well as of ripening of a variety may vary from a few days to three or four weeks from year to year with the different varieties, depending on climatic conditions. Slight fluctuations sometimes occur in the relative ripening dates of varieties, although within a given orchard these differences are small. At different elevations and under other varying conditions both blossoming and ripening dates of a variety may differ considerably even in adjoining orchards. The conditions that prevail in low, wet, heavy lands and at high elevations tend to cause late blossoming and ripening of the fruit, while those that characterize the well-drained soils of low, rolling land, especially those of southern and eastern exposure, favor relatively early blossoming and ripening.

Considering the principal plum sections in California, in which are grown more or less extensively nearly all varieties of plums produced commercially in the Pacific States except the Italian prune,

XUM

harvesting starts during the latter part of May in the foothill section near Vacaville, in Solano County. In the Vaca Valley, which borders these foothills, the earliest harvests are about one week later and almost simultaneous with the foothill section of Placer County and a few days in advance of the main portion of the Sacramento and San Joaquin Valleys.

The principal variety grown for fresh shipment in the other States included in this discussion—Oregon, Washington, and Idaho—is the Italian prune. Other varieties grown commercially in these States include Tragedy and Pond, with less important plantings of California Blue, Diamond, and a few others. The ripening dates of these varieties in the Pacific northwest are three or four weeks later than in the plum-producing sections of California. Only a few varieties are favored for planting in the Pacific Coast States at the present time, although large fruit shipments are made from many other varieties that were planted in recent years.

A few important qualities of the most prominent commercial varieties growing on the Pacific coast at the present time are here described to guide the orchardist in his choice for future planting. These varieties represent three groups or classes of plums: (1) The Japanese sorts, those derived from the oriental form known to botanists as *Prunus salicina*, including many varieties grown for their fresh fruit; (2) those derived from the European form (*Prunus domestica*), which includes the so-called "European," "domestica," "purple," or "blue" plums and to which belong the varieties grown for prunes as well as many for shipping fresh; (3) hybrid sorts originated by crossing Japanese with native plums, grown for use in the fresh state.

VARIETIES OF PLUMS AND PRUNES IN THE PACIFIC STATES

VARIETIES OF THE PRUNUS SALICINA (TRIFLORA) GROUP AND ITS DERIVATIVES OR HYBRIDS

Beauty.—This is the earliest ripening of the commercially grown varieties and is therefore a favorite in sections where fruit is produced for the early market. Cross-pollination is not essential. The tree is thrifty and inclined to bear well and regularly; thinning the fruit is found necessary almost every year. The fruit is medium in size, often with considerable variation on the same tree. It is very attractive and carries to the market fairly well. This is the most popular early ripening variety at present.

Burbank.—This is one of the principal varieties of the Japanese group grown on the Pacific coast. Its harvest comes after the Climax and Maynard and just before the Santa Rosa. The fruit is medium in size and quality and carries to market exceedingly well. The Burbank is a regular and prolific bearer, and unless thinned the fruit is often undersized. The blossoms are self-sterile, but appear with those of many other varieties which, if near by, are usually sufficient to pollinize it. The ripening season is rather long. The tree is thrifty, spreading in habit of growth, and suited to a wide range of climatic conditions. This variety is planted for its regular and heavy crop of fruit, but it ripens in the middle of the plum-shipping season, and low prices are sometimes received for it.

Climax.—Fruit large and attractive, but ripens rapidly, is rather soft when ripe, and therefore requires considerable care in harvesting and must be hurried to market. The blossoms are self-fertile, and regular crops of fruit are therefore expected.

Duarte.—Fruit very large, of good shipping quality, and has attractive dark-red flesh. This is the earliest to ripen of the so-called "blood" plums, but one of the latest of the Japanese type of varieties grown for fresh-fruit ship-

ment. Its blossoms are self-sterile, but appear late, and good crops are expected where the trees are planted near other varieties of the same group.

Formosa.—While among the earliest ripening varieties, its fruit is very large. It is one of the most attractive of commercial plums, of excellent eating quality, and carries to distant markets exceedingly well. The blossoms open early in the spring and therefore are in danger of being injured by frosts and are self-sterile. The tree is thrifty and grows to a large size, but is inclined to come into bearing late. As a result, many orchards of it have been top-grafted to other varieties and its planting has been nearly discontinued. Good crops have been harvested where trees are growing near the Wickson, the Santa Rosa, and some other varieties of the Japanese type and when there is an abundance of bees. The yield of this variety is usually the best when it is top-grafted on old trees.

Gaviota.—Fruit very large, attractive, of good eating quality, fair in texture, and keeps and ships exceedingly well. The blossoms appear rather late, and the fruit ripens among the latest of the varieties of this type and a little after midseason for fresh-plum shipments. On account of its firm flesh the fruit may be harvested over a long season and if picked when well ripened will still reach the market in good condition. The trees are vigorous, prolific, and inclined to be regular in bearing if the blossoms are pollinized. Its blossoms are self-sterile, and the trees should therefore be planted near other varieties of the same group which blossom at the same time. This variety is still popular for planting.

Kelsey.—Fruit large, of good eating quality, attractive when well colored, keeps and ships well, has a rather long ripening season, and is one of the latest of the more extensively grown Japanese varieties. The fruit colors well in sections where cool summer breezes prevail and in foothill sections, but poorly in the hot floor of the interior valleys of California where fruit for fresh shipment is grown extensively. Its blossoms are self-sterile, but it usually bears well when planted with closely related varieties. In sections where the fruit colors well this variety is now popular for planting.

Santa Rosa.—This variety is harvested somewhat before midseason, and the ripening season is longer than for many varieties of Japanese plums. The fruit is large and very attractive, purplish crimson in color, having dark-red flesh of fine eating quality, and carries well to market. It blooms early, and the blossoms are sometimes injured by frost. It is benefited by cross-pollination and on account of late frosts and faulty pollination is inclined to be irregular in bearing. The Wickson and Beauty varieties, blossoming about the same time as the Santa Rosa, have been recommended for planting near it for pollinizers. The tree is a vigorous, compact, upright grower and should be pruned to induce a moderate new growth and an open framework. Severe cutting back of the tops causes a long, erect growth of new wood which forms a compact top, thus heavily shading the branches and spurs of the old wood. This is now a favorite among Japanese plums for planting.

Satsuma.—Fruit of good size, dull red in color, and purplish red flesh. It is of good flavor, high in dessert quality, and favored for culinary purposes but not for shipping fresh, although a small acreage is grown for this purpose. The tree is vigorous, but inclined to bear light crops until it reaches several years of age.

Wickson.—Fruit very large, attractive, good in flavor and dessert quality, and carries to market well. It is one of the earliest varieties to blossom in the spring, and late frosts often shorten the crop. It requires cross-pollination. As it blossoms with but few other varieties, light crops sometimes result from lack of other pollen. It is planted more extensively along the Pacific coast, probably, than any other variety of the Japanese group.

VARIETIES OF THE PRUNUS DOMESTICA GROUP

Agen (*French prune or Petite prune*).—The fruit of this variety is perhaps the smallest of any of those used for prunes. It is dull reddish purple in color, very rich and sweet in flavor, and has a rather tough skin. As the sugar content is high, it dries quickly and easily. The tree is thrifty, a moderately vigorous grower, and regular and prolific in its bearing habits. It blossoms in midseason for the prune varieties and ripens its fruit late. The fruit clings to the tree until after drying starts, which insures against injuries during harvest, thereby shortening the period which would otherwise be required for it

XUM

on the drying trays. The planting of this variety exceeds by many times the combined area of all other varieties grown for prunes in California, and it is of commercial importance in western Oregon and western Washington. Its blossoms are self-fertile, and it may therefore be planted in solid blocks, although interplanting with the Sugar and Imperial Epineuse varieties has been recommended as a benefit to fruit setting. It requires a deep fertile soil for the production of good crops of large fruit. Adverse local conditions or overheavy crops result in small fruit. An abundant supply of small fruit, with prices on a size basis, is the chief hindrance to a satisfactory market price for this variety.

California Blue.—Fruit ripens in midseason, is medium to large in size, round, bluish in color, of only fair dessert quality and flavor. Its ripening period is rather short. The tree is very prolific, but it bears only in alternate years, at least in some localities. Its blossoms are self-fertile. The tree is inclined to branch but little, is spreading and open in habit, and produces fruit on wood of all ages, making the harvest easy. As yet its culture has been confined mostly to a few sections in central California near which it was originated, although it is giving encouraging results in central Washington orchards. It is not favored for planting at present.

Clyman.—Ripens earliest among the domestica group of plums on the Pacific coast and follows closely the earliest of the Japanese group. It is dark blue in color, of medium size, fair in eating quality, and carries only fairly well in shipment. The blossoms are self-sterile, open early, and the trees should therefore be interplanted with other early-blossoming varieties. The Tragedy variety has been suggested as a pollinizer.[8] Clyman is not a dependable producer in most sections, probably on account of lack of pollination and injury by frost. The tree is a vigorous grower and favored as a stock for top grafting, but is no longer planted for fruit production.

Diamond.—Fruit large, handsome, rather sour, and second rate in eating quality, but its tartness has made it a favorite during late years in eastern markets. It is firm in texture and carries well to distant markets. Its fruit ripens a little after midseason and is the first purple plum of commercial importance to ripen after Tragedy. The wood of this variety makes probably the poorest union with the peach stock of any of our commonly cultivated plum varieties.

Golden Drop.—Known as "Silver prune" on the Pacific coast. Fruit large, of good dessert quality, and keeps and ships well. On account of its golden yellow color it is suited for canning, but not popular for shipping fresh. It is one of the later ripening varieties used for canning, but is not so popular now as in past years.

Giant.—Fruit medium to large in size, attractive in appearance, but lacking in flavor and juiciness. Owing to its rather dry flesh it carries to market exceedingly well. Its blossoming season is late, and the fruit ripens among the late varieties commonly grown for their fresh fruit. The fruit is about midway in size between that of its parents, the Agen and Pond. Like the former the tree is vigorous, its blossoms are self-fertile, and it fruits heavily from year to year. It resembles the Pond in that the fruit is somewhat lacking in flavor and juiciness and is rather coarse. It is not popular for planting at present.

Grand Duke.—A plum which has been widely tested in plum-growing centers of the Pacific States and is extensively planted in California. Its fruit is large, attractive, firm, not very juicy, has a high sugar content, keeps and ships well, but is second rate in dessert quality. The blossoms appear late and require cross-pollination. The fruit ripens late and the ripening season extends over a comparatively long period.

Imperial Epineuse.—Fruit large when compared with that of other varieties grown for shipping fresh and larger when dried than that of other varieties commonly used for prune making. It is dark red, juicy, of good quality and appearance, and excellent in eating quality. Owing to the high prices paid for the dried fruit, the larger portion of the crop of this variety is made into prunes. The tree is vigorous, but inclined to be a shy bearer in most localities, this being due, probably, to the lack of cross-pollination. The Agen and Sugar varieties have been recommended for interplanting with the Imperial Epineuse as pollinizers. The tree requires a deep, fertile soil for satisfactory growth. This requirement, together with its irregular cropping tendencies, has prevented it

[8] Hendrickson, A. H. Plum pollination. Calif. Agr. Exp. Sta. Bul. 310, p. 18. 1919.

from being extensively planted in some plum centers. It is at present grown to a limited extent in many places and in the Sonoma Valley is one of the most favored varieties.

Italian Prune.—Fruit medium to large, dark purple in color, of a pleasing tart flavor, and firm in texture, making it first class both for fresh shipment and for drying. It is also used largely for canning. It is grown extensively for these purposes in Oregon, Washington, and Idaho, where it is by far the most important variety under cultivation and one which is still the most extensively planted. The blossoms are self-fertile, and therefore it may be planted in large blocks without other varieties. It is adapted to a wide range of temperature, but requires a deep, fertile soil.

Jefferson.—Fruit similar to Golden Drop and used for canning, as is that variety; it is one of the most popular varieties for that purpose. Although a fruit of good eating quality and flavor it is not favored for fresh shipment on account of its color. Due to the very restricted demand for plums for canning, the demand for trees of this variety for planting has nearly ceased.

President.—Fruit large in size, very dark purple in color, of fair eating quality and texture, ripens among the latest of the purple domestica plums, and carries to the market well. The tree is thrifty and inclined to bear regular and heavy crops. It is recommended for planting by those who wish to grow late-ripening plums for the fresh market.

Pond.—Called "Hungarian prune" on the Pacific coast. Its fruit is large for the commercially cultivated varieties of this group, very attractive, and purplish red in color. Its flesh is firm and lacking in juiciness, making it well suited for shipping. In eating quality it is only second or third rate. There is a tendency for the fruit to form doubles, one side often being imperfect in shape. Such fruits are not favored in the markets and are difficult to pack. Its blossoming season is intermediate with other plums and its fruit-ripening season is late. The branches make a slender upright growth and are inclined to send out too few fruiting twigs and branches. The tree should be pruned to induce a moderate wood growth and branching. In the interior valleys of California, where the summers are hot, the tree is lacking in vigor. There is often a poor wood and leaf growth and considerable sunburning of wood and fruit. In States farther north, where the summer temperatures are lower, the tree is thrifty and productive, with decidedly less injury from sunburning.

Reine Claude.—Considered one of the best varieties for canning, but on account of the small size of the fruit and the light demand for plums for canning, its planting has been almost discontinued.

Sergeant (*Robe de Sergeant*).—Fruit somewhat below the medium size of varieties of this group grown for their fresh fruit. When dried it is about medium size among the prunes. Its dark-purple color, becoming almost black when the fruit is ripe, and its rich pleasant subacid flavor make it well suited for prunes. The tree is thrifty but often fails to bear satisfactory crops, especially in the cooler sections. It is considered profitable only on deep fertile soil, as elsewhere the fruit is too small. This variety has been grown to a considerable extent in California, although new plantings of it are rare both there and in the States farther north.

Sugar.—Fruit medium in size when compared with other varieties grown for fresh shipment, although considerably larger than its parent, the Agen. It is dark purplish red in color, juicy and has a rather tender skin. It is sweet, but otherwise second rate in dessert quality. The blossoms appear late, making them comparatively free from danger of frost injury. Being also self-fertile good crops are usually insured. The trees of this variety are inclined to be prolific. If the fruit is not thinned, small sizes usually result, and an excessive crop is often followed by a light one or a failure the following year. The tree is open and spreading and the wood very brittle and inclined to become stunted where little pruning is done. Good soil and cultural conditions are required for a satisfactory tree growth. When the market price for plums is low, the fruit is dried into prunes, although considered only second class for this purpose. While less popular at present than in past years, it is still found in practically all centers of plum production in the Pacific States.

Tragedy.—One of the earliest and best of the domestica plums for fresh shipment, both as to eating quality and for profitable returns. It is a favorite variety in those sections of central California from which fresh plums are shipped, and it is grown to some extent in parts of eastern Washington. Its

XUM

fruit is medium in size for a domestica, attractive in appearance, and ships well. The blossoms are self-sterile, and poor crops often result from this cause. The Clyman has been recommended as a pollinizer.

Yellow Egg.—Fruit large, only fair in eating quality, and rather soft when ripe, making it inferior in this respect for fresh shipment. Its golden yellow color makes it suitable for canning, but not for selling fresh. For canning it is one of the most favored varieties, but the decreased demand for plums for canning has resulted in the top-grafting of some orchards of this to other varieties. The trees are vigorous and inclined to bear regular and heavy crops.

POLLINATION

Among the foremost of the considerations to be given to the planting of plum orchards is that of pollination. This is more especially true with varieties for fresh-fruit shipment, for many common varieties grown for this purpose are entirely sterile with their own pollen, or the crop may be greatly increased by cross-pollination. To the lack of pollination many light crops or entire failures may be attributed. In some instances the planting of a variety has been discontinued on account of poor crops from this cause.

The most practical means for providing cross-pollination in commercial orchards is to interplant varieties which may be fitted into the scheme of a ripening succession to extend the fruit harvest. In the interplanting of varieties it may be convenient to plant the succession so as to accommodate fruit-picking crews, but this should be done in every case to favor pollination. Only a few rows of a variety known to be entirely or to a large degree self-sterile should be planted together. Solid blocks of these varieties should never be planted, as with self-sterile varieties. For convenience in fruit harvesting, from two to four rows of a variety are usually planted together.

In the selection of a pollinizer, provided more than one variety will cross readily with the one to be pollinized, a variety which blossoms with it, having a long blossoming period and regular in blooming habits, should be chosen rather than one which tends to blossom in alternate years.

As a group the Japanese varieties and those derived from them are considered to require cross-pollination or to be greatly benefited by it, with the exception of the Climax, which is self-fertile. Among the domestica varieties (the only other group represented in commercial plum planting in the Pacific States), the Tragedy is self-sterile, as are also the Imperial Epineuse and other less important varieties. Several of them, including two important varieties for prune production—the Agen and Italian prune—are self-fertile.[4]

While varietal tendencies regarding pollination are very decided, the percentage of blossoms to set fruit, irrespective of weather conditions, varies with the age and thrift of the tree. Where top-grafted on older trees, especially if the stock and scion are somewhat uncongenial and produce an imperfect union, a heavier set of fruit sometimes results than from normal trees. Heavy crops under these conditions have been noted in the case of the Formosa variety. This is a self-sterile sort and notorious for coming into bearing late. Eight-year-old grafts of the Formosa in old apricot trees adjoin-

[4] For results in cross-pollination with the common varieties of plums, see Hendrickson, A. H., Plum pollination. Calif. Agr. Exp. Sta. Bul. 310, p. 1–28, 5 fig. 1919.

ing Santa Rosa trees have been observed to bear excellent crops, while 8-year-old Formosa trees started in a nursery and planted the same distance from the Santa Rosa trees as were those produced by top-working bore practically no fruit.

The presence of bees in the plum orchard at blossoming time has been demonstrated to be almost an economic necessity. (Fig. 10.) Poor crops or perhaps failures may be expected of self-sterile varieties where no bees are present, and even with self-fertile varieties the presence of bees has caused a decided increase in the crop.[5]

Cold, foggy, or rainy weather at blossoming time is very detrimental to the setting of fruit. A careful selection of varieties must be made for planting in places where such weather is common during the spring, and commercial plantings should be confined to varieties which have proved themselves suitable to the local conditions.

FIGURE 10.—Bee stands in a plum orchard. Cross-pollination in plum and prune orchards by bees has been proved of so much importance that many of the growers in California place stands in their orchards, at least during the blossoming period

STOCKS USED IN PROPAGATING PLUM TREES

Only a small portion of the plum trees for commercial planting are propagated in the home nursery, professional nurserymen being depended on to supply trees with stocks suited to the orchard conditions. In his selection of stocks the nurseryman is guided by the demand of orchardists for trees propagated on one stock or another and by his own interest in producing cheaply propagated trees which make a rapid growth.

For propagating plum trees the myrobalan plum and the peach are by far the most important, although the almond is used in some localities, at least in California. An occasional orchard may also be found where the Marianna plum and the apricot are used for stocks. Each of the first three stocks mentioned is suited to different soil conditions, and the myrobalan plum and the peach are suited to the soils generally chosen for plum planting. The myrobalan plum is preferred for deep, heavy fertile soils, especially if the rainfall is

[5] Hendrickson, A. H. The common honeybee as an agent in plum pollination. Calif. Agr. Exp. Sta. Bul. 274, p. 125–132, 2 fig. 1916.

heavy or the orchard is under irrigation. It is not a rampant grower, but is a vigorous, long-lived, hardy, and deep-rooted tree, the roots withstanding a higher soil-moisture content than other kinds of roots. The myrobalan plum, however, prefers a deep, fertile, heavy, well-drained loam and is therefore at home in soils favored for prune production and is in most general use in that industry. It is also the one most commonly used for planting in the deep, fertile bottom lands, where plums are grown for the fresh-fruit market and for canning.

The peach root, while less resistant to excessive soil moisture than the myrobalan plum, will thrive better than the latter or other stocks mentioned in poor, shallow, or light soils, because its roots do not go so deeply into the earth, but make a vigorous spreading growth. A good moisture content and a soil of good tilth are, of course, required

FIGURE 11.—Old apricot trees top-grafted to plums. The trees on the left have just been grafted; the scions will start into growth as the trees renew their activities in the spring. On the trees at the right the grafting was done five years before. (Vacaville, Calif.)

for the best root growth of the peach. It starts growth early in the spring, grows rapidly, succeeds in a wide range of soils, and is generally considered the most satisfactory stock for early-ripening plum varieties, at least in the shallower soils, where these varieties are extensively grown. It is used to a considerable extent for varieties for prune making where the soil is not sufficiently deep or the moisture content is below that required for the best development of the myrobalan roots.

The almond, one of the stocks used in California, is a thrifty long-lived tree, growing best in deep fertile well-drained soil and is the most drought resistant of the stocks commonly used. It does not withstand excessive soil moisture as well as the peach or the myrobalan plum, but succeeds in places where it is too dry for those stocks. The plum tree is generally considered to grow less rapidly on the almond root than on the others commonly used and is propagated less extensively on it than on the others. The almond is used to some extent as a stock for prunes in deep fertile soils not under

irrigation. Large old prune trees which have excellent records of fruit production are found growing on this stock.

The Marianna plum is employed as a stock for plums in California, but it is more sensitive to drought and to excessive soil moisture than the other stocks, suckers badly, and is generally little used. It grows quickly and well from cuttings, which insures cheap and uniform stocks.

In the Northwestern States the myrobalan plum has been used almost exclusively as a stock since plum growing became an important industry there; but in California, where fruit growing is a more diversified industry and the growing of plums for fresh shipment is a comparatively new enterprise and the demand for different fruits has fluctuated considerably, the stock which is at present considered best for planting under a given condition is not the one found in the orchard in a great number of instances. Much superficial testing of different stocks has been in progress, and the changing popularity of varieties has caused many orchards to be top-grafted to other fruits or varieties, although the tree which then becomes the stock is not in all cases the one on which the new variety should be grown.

TOP-WORKING

The principal reasons for top-working in the commercial orchard are the changing demands of the market in regard to the variety and quality of fruit and the desire to bring the trees quickly into production. (Fig. 11.) As there has been an ever-changing demand in plum varieties, especially those for fresh-fruit shipment, much top-working of trees has been done in sections of central California where the growing of plums for fresh shipment is an important industry. In these sections top-grafting has been practiced since commercial plum growing was first established, and it is still a common procedure. It has proved to be a satisfactory method for changing the production of an orchard from one variety of plums to another, for the replacing of certain other fruits with plums, and for testing new varieties by bringing them quickly into bearing. (Fig. 12.) Only a few years are required for the new top to come to commercial production where conditions for fruit growing are good and where varieties inclined to be prolific are used. A crop of 1 to 2 crates of plums per tree has been harvested the second season after top-grafting, thus causing an interruption of only one year without a marketable crop in changing trees from one variety to another. This, however, is a more rapid change than would usually be expected. The top-grafting of peach trees to plums was practiced to a large extent in this region a few years ago, owing to the popularity of the plum as compared with the peach.

The operation of top-grafting is easily performed, and success may be expected if the trees selected are vigorous. The work of top-grafting is usually done in winter and spring after the pruning has been finished. In performing this work only strong, well-spaced, and well-shaped branches should be selected. These should be carefully sawed off at the desired height and the scions inserted by either the cleft or bark-grafting method. As large wounds heal slowly, making the entrance of wood-rot fungi probable, small branches are pre-

XUM

ferred to large ones. If a limb 2½ or 3 inches in diameter or a little larger must be selected, at least three scions should be inserted, while for the smaller branches two are sufficient.

Instead of top-working by grafting, budding into small branches which grow from cut-back limbs is sometimes practiced for changing the tree from one fruit to another.[6]

In top-grafting, the unfortunate use of scions of varieties which do not form strong unions with the stock has resulted in the loss or poor growth of many trees. While the varieties of Japanese plums most commonly grown are inclined to be congenial with the peach stock, a number of varieties of the domestica group are not. (Fig. 13.)

The Diamond, Grand Duke, and California Blue varieties when grafted on peach make perhaps the poorest unions among the varieties of this group in the region under observation, although the

FIGURE 12.—An orchard of top-grafted plum trees at Vacaville, Calif., June 4, 1921. These trees were originally the Kelsey plum. They were top-grafted eight years before to the Beauty plum

tree may continue to bear profitable crops over a considerable term of years after grafting. When a variety is top-grafted to an uncongenial stock it will often appear undernourished, owing to the inability of the plant food to pass readily into the tissue below the graft union. The poor growth of foliage resulting from this condition causes poor protection from the sun; the old branches of the stock sunburn easily and are therefore more easily broken by the wind than where good unions are formed with the scion. (Figs. 14 and 15.)

The plum on the apricot or almond sometimes gives unsatisfactory results in top-grafting, while good unions are expected in grafting one variety of domestica plum with another, and in grafting Japanese varieties on domestica varieties. Trees known to form poor unions with the variety the orchardist wishes to grow are sometimes top-grafted with a variety known to unite well with both, and the

[6] Hendrickson, A. H. Prune growing in California. Calif. Agr. Exp. Sta. Bul. 328, 38 p., 12 fig. 1921.

next year these grafts are worked to the variety chosen for fruit production. (Figs. 16 and 17.) "Double working," as this practice is commonly termed, may be used in some instances to decided advantage if the trees to be top-grafted are large and well shaped and the grower does not wish to remove them.

To secure an open growth for a variety naturally compact and upright growing, the variety is top-grafted on one that is naturally open and spreading. This is done after the spreading tree is 2 or 3 years old and has its framework branches established. (Fig. 18.)

That there may be a strain or some other obscure factor involved in the congeniality of stock and scion is suggested in Figures 19 and

FIGURE 13.—Poor graft unions resulting from top-working old peach trees with the Grand Duke plum. The plum grafts are 12 years old. Note the enlargement of the lower portion of the grafts and injury from sunburn below. (Vacaville, Calif.)

20, which show the Agen prune top-worked on almond trees. In one case faulty unions have developed; in the other, congeniality appears to exist. Other similar instances are matters of observation.

Prior to actual trial there is apparently no means of determining what plum or prune varieties will show congeniality with particular stocks. For example, the Agen (*French prune*) has given excellent results when top-worked on apricot, though the plum wood at the point of union may grow somewhat larger than the apricot wood. The Agen propagated in the nursery on almond stocks sometimes makes a good growth, and the trees are long lived and vigorous. On the other hand, in the case of the Imperial Epineuse plum, after growing for nearly 25 years the limbs top-grafted on a myrobalan plum tree began to indicate weakness at the point of union.

XUM

It does not necessarily follow that a variety propagated in the nursery on a particular stock and grown successfully in the orchard will give the same successful results if top-worked into a mature tree of the same species as the seedling nursery stock.

The work of top-grafting is not difficult or complicated. With moderate skill and a little practice one may expect a large percentage of his scions to grow. As the new top grows, all rough portions of the stubs in which the scions were placed should be carefully removed with a saw and chisel to insure the healing of the stump as quickly as possible. Where tree tops are removed for grafting, the stumps not needed should be carefully removed and the others protected

FIGURE 14.—A poor union of the Grand Duke plum on a peach tree, resulting in poor growth, sunburning of the limbs, and subsequent decay and weakening of the branches. Such branches are easily broken by winds

from the sun with whitewash, especially if the trees are young and their branches are not protected by thick bark. The growth of young branches to furnish shade should be encouraged also. Carelessness in grafting and neglect of the old stumps and branches in succeeding years, both through failure to remove dead stumps of branches or portions of them which the new scion can not overgrow, has often resulted in sun scald, followed by the entrance of wood-decaying organisms and the ultimate loss of the tree. Such losses usually follow several years of unsatisfactory crops of fruit, and are by far the most severe on top-grafted trees where stock and scion are somewhat lacking in affinity. (Fig. 21.) Wood-decaying organisms, entering through grafting wounds or sunburn following grafting, are a very common cause of loss of top-grafted trees and necessitate the removal of a large number of trees annually. Often

the removal of the entire orchard is necessary, owing to the poor stand of thrifty trees remaining after the removal of dead or unprofitable ones.[7]

DISTANCE FOR PLANTING

From 18 to 24 feet has been the range commonly used for spacing plum trees in the orchard, 20 feet each way being the most common distance. Where soils are fertile but the trees of the varieties planted are naturally small or upright in habit of growth or conditions are not generally suited to the production of large trees, the shorter distances are usuallly preferred. They are also sometimes preferred where a method of prunning is used to maintain low compact heads, provided water for irrigation is available so that the trees can not rob each other of their needed moisture supply. For trees naturally thrifty and planted for a permanent orchard 20 feet each way is generally considered the best distance. In fertile, well-watered soils 26 to 28 feet each way is believed best for naturally large-growing prune trees.

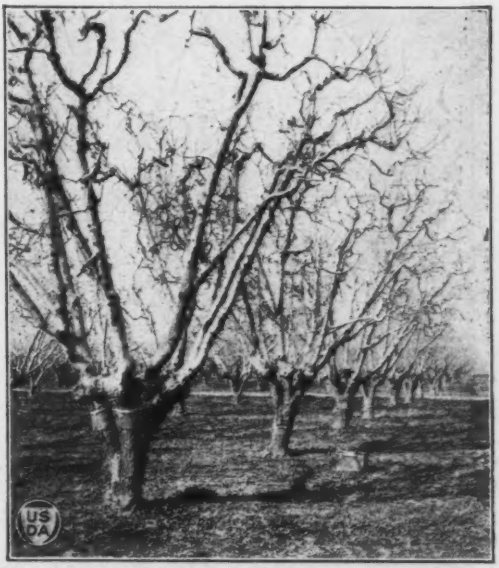


FIGURE 15.—A row of peach trees which were top-worked to the Diamond plum. The enlargements at the points of union between the peach and plum wood indicate a lack of congeniality, although a fairly strong growth has been made by the plum top. The plum tops are about 20 years old

Planting too close has been the cause of many light fruit crops, of alternate bearing of trees, and of the generally poor production which is common in some districts. If close planting is practiced where the soil is of only average depth and quality, or where irrigation is lacking, or where culture is in part neglected, only irregular crops and slow, weak growth may be expected after the trees are a few years old and the roots have occupied all the land. Where ideal cultural conditions prevail, with a pruning program suited to the variety and conditions, fair yields may be expected even with close planting. (Fig. 22.)

NURSERY TREES FOR PLANTING

One-year-old trees of average size are considered most suitable for orchard planting. All trees should be propagated on the kind of

[7] For a report on grafting affinities with special reference to plums, see Calif. Agr. Exp. Sta. Bul. 438, Nov., 1927.

XUM

stock best adapted to the land to be planted, and all should be free from injurious insects and plant diseases. Provided the interstate and intercounty quarantine regulations have been properly carried

FIGURE 16.—Top of a seedling plum tree (in the foreground) two years after being double worked on apricot. A short section of Pond (*Hungarian prune*) is between the base of the plum limbs and the apricot. The tree therefore shows an apricot base top-worked to the prune, which in turn was grafted over to a seedling variety of plum

out, there will be but little risk in regard to insects and diseases when buying a nursery tree, and the purchaser should make sure that all provisions of the law pertaining to the sale of nursery trees in his

locality are strictly adhered to. Nursery trees with a well-developed system of thrifty roots and of average size rather than very small or extra large should be chosen.

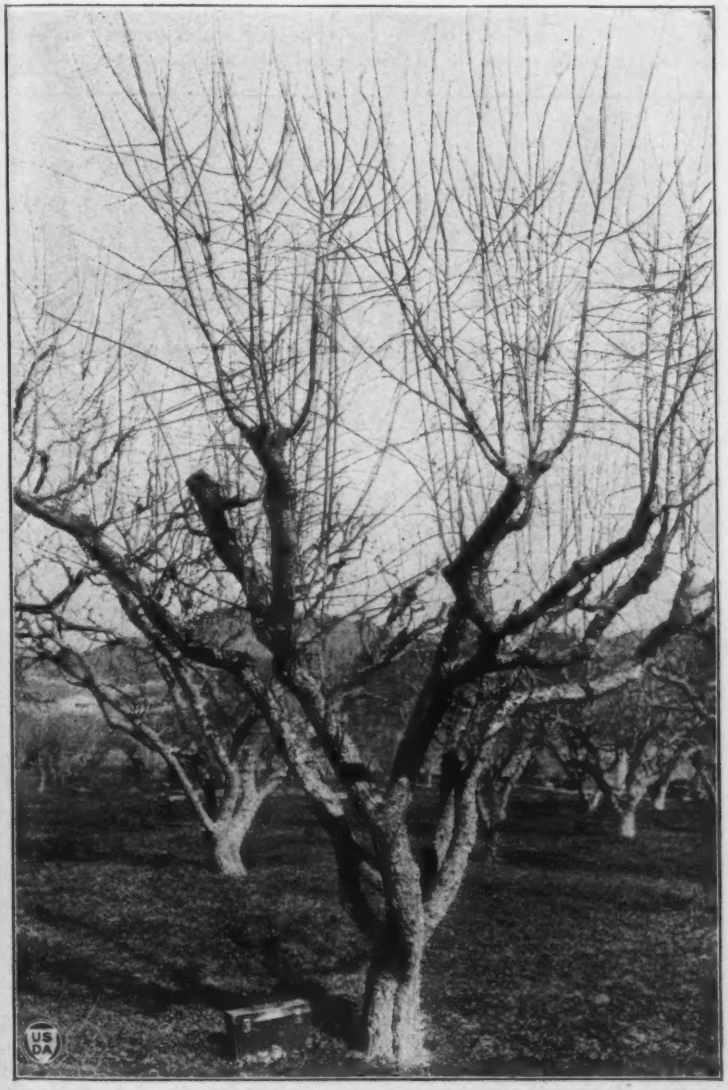


FIGURE 17.—Scions of the seedling plum referred to in Figure 16 grafted directly into apricot limbs. The growth of the plum branches, where double worked with sections of Pond (*Hungarian prune*) wood between the plum and the apricot, is appreciably more vigorous than in the present case. This obviously suggests, although it does not prove, that double working in this combination is advantageous

TIME FOR PLANTING

As with other deciduous fruits, plum trees should be planted sufficiently late in the fall so that new wood will not start growth until the following spring, or they may be planted in the spring while the soil is still cool and before the time for wood growth to start. The trees should never be planted until the soil has been well pre-

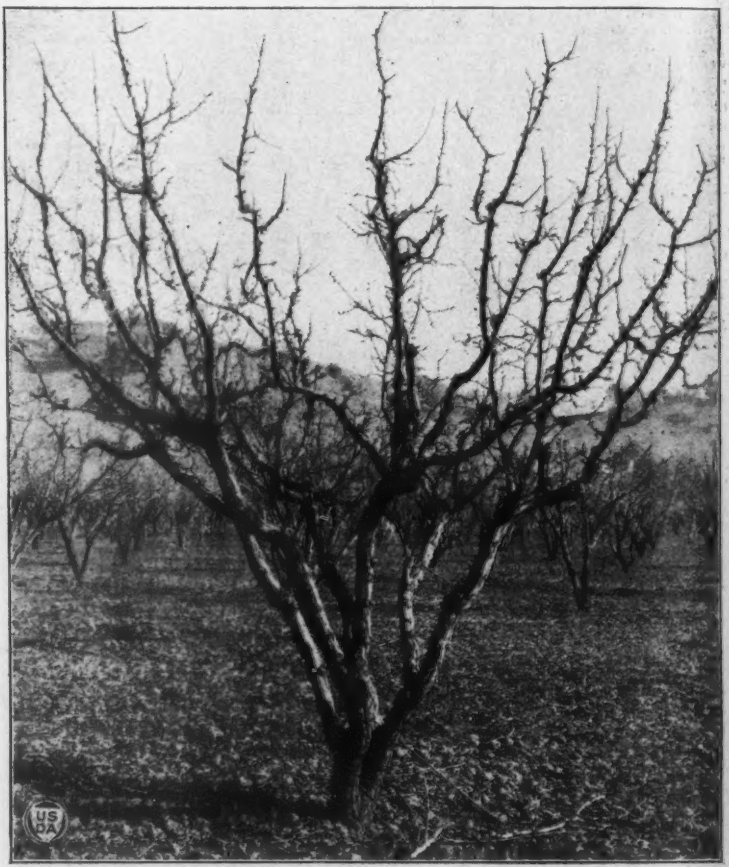


FIGURE 18.—The Formosa plum, an upright-growing variety, top-grafted on a 5-year-old peach tree to make an open top. (Vacaville, Calif.)

pared and is sufficiently moist to prevent the roots from becoming dry. In California, western Oregon, and western Washington, where the winter temperatures are mild, plantings may be made at any time during the winter and even until after the 1st of March, with little fear of injury to the trees.

Loss of trees from carelessness is a common occurrence in newly planted orchards. Where planting is for any reason delayed after

the trees are received from the nursery they should be heeled in carefully in a light, moist soil until ready for planting. Care must be taken to protect the trees from the sun and drying winds while

FIGURE 19.—An Agen (*French prune*) tree top-grafted on an almond stock. The union between the almond and the prune wood is poor, and the growth of the prune top is unsatisfactory. Sprouts have been allowed to grow on the almond portion of the tree for the purpose of nourishing the roots. In some instances this practice has resulted in a marked improvement in the general condition of the tree. It would appear that in this case almond roots can maintain the Agen prune top, but that the food material elaborated by the latter does not adequately maintain the almond roots

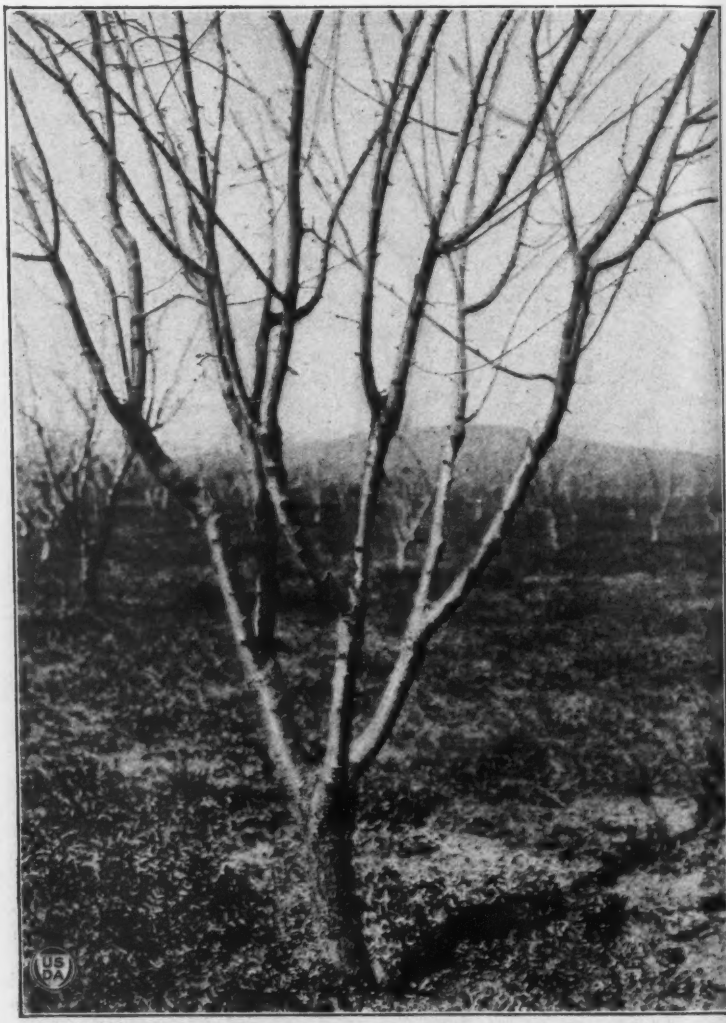


FIGURE 20.—An almond tree the main limbs of which, like the one shown in Figure 21, have been top-grafted to the Agen (*French prune*). This tree stands next in the row to the one shown in Figure 21, but the congeniality between the almond and the prune appears to be satisfactory, and the tree is thrifty. A varietal strain or other obscure factor may explain the difference in the congeniality in these two instances

handling, for neglect at any time from digging in the nursery until planting in the orchard may result in loss or delay in growth.

ORCHARD CULTURE

The cultural operations as practiced in most commercial plum-growing centers of the Pacific States are a combination of cultivation, irrigation, and the growing of cover crops. Where water for irrigation is available these operations are closely related, and the performance of one is often dependent on the other. In nonirrigated sections cover crops must be handled at the convenience of cultivation. As most of the annual rainfall in the plum-growing centers of these States is confined to the fall, winter, and spring seasons, occurring mostly while the trees are dormant, and as the summers are hot and dry, cultivation to destroy vegetation and thereby prevent the loss of moisture through it is important if irrigation is not practiced. Under these conditions it is the custom to plow to a moderate depth as early in the spring as the soil becomes sufficiently dry to work well, following the plow with some tillage implement designed to smooth and loosen the surface.

FIGURE 21.—Sun scald and decay in a peach stock which resulted from top-grafting with an uncongenial variety of plum, followed by neglect in caring for the stumps of branches removed in top-working

Too much care can not be given to the choice of the time for this spring plowing. If the soil is worked while too wet, so that it is compacted, as in the case where the surface of the furrow is left shining when it is turned by the plow, the soil will dry out hard and only an ineffective soil mulch can be established. In this condition the moisture content below will be endangered and disintegration in the compact soil delayed, with the result that the development of the food supply for coming years will be retarded. Adobe soils, which in some localities are planted to plums, must be plowed when wet, but such soils crumble or slake to some extent upon drying and may then be worked to the desired texture. On the other hand, if the soil is too dry when first plowed the operation will be difficult and usually

XUM

poorly done. The soil will turn up cloddy and only an ineffective soil mulch can be formed, thereby permitting further drying of the subsoil. When the moist soil crumbles into small particles upon leaving the plow, covering well all vegetation, subsequent tillage is more effective and conditions for the fruitfulness of the trees much better than if the land is plowed when either too wet or too dry. During the remainder of the summer, shallow-going tillage implements are used at intervals to stir the soil and destroy vegetation for the conservation of soil moisture.

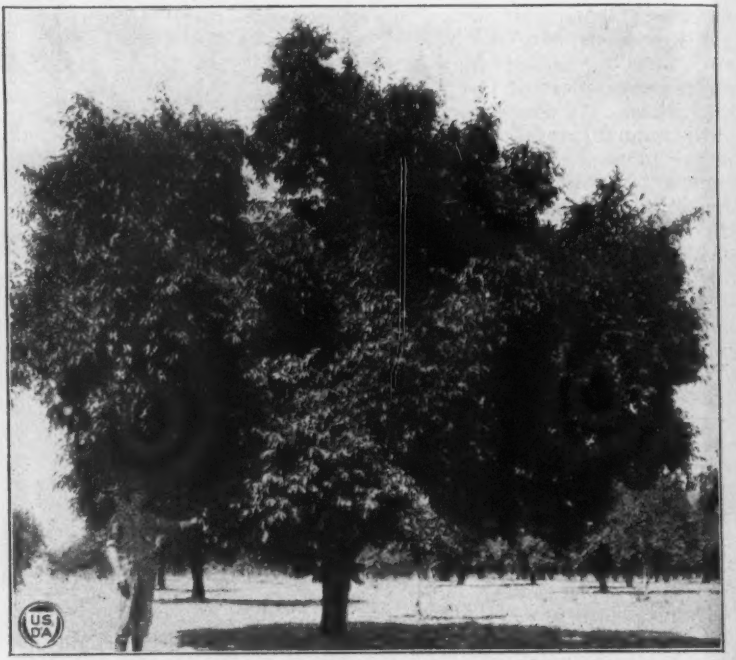


FIGURE 22.—A 30-year-old Italian prune tree which is prolific and bears regularly while standing where it is not crowded. Under similar soil conditions in a near-by orchard, but with the trees planted 18 by 18 feet, the growth of the trees is poor and the production irregular. (Douglas County, Oreg.)

It is claimed by both growers and buyers that plums from soils that are nonirrigated but well cultivated are better in eating quality, carry better when shipped fresh, and dry into heavier prunes than when grown on land where frequent and abundant irrigations are given.

The number of cultivations required under the local climatic and soil conditions must be determined by the orchardist, who must fulfill but not exceed the demands of economy in his orchard cultivation expenses.

To eradicate noxious weeds, of which the grasses and the morning-glory are the most troublesome, frequent plowing instead of the use

of shallow-going implements for stirring the surface soil is necessary.

Where cover crops are grown in nonirrigated sections care must be taken that plowing be done when the soil is in the proper condition. Spring plowing is sometimes delayed to permit a heavier growth of the cover crop, but with doubtful benefit in nonirrigated sections, since in such sections soil moisture is the principal limiting factor to successful plum production. Cover crops are highly desirable if their growth is made during the fall or before the soil has become sufficiently dry for plowing in the spring, but not so if grown at the expense of moisture which should be retained for the trees. If plowed so late that the cover crop does not decay promptly a free passage for air will be provided and a rapid drying of the subsoil will follow.

Systems of tillage and cover cropping are considerably modified in irrigated sections as compared with those nonirrigated. Under irrigation the soil moisture taken by the cover crops may be replenished and cover crops managed more to the pleasure of the orchardist. The soil may be prepared at any time for seeding these crops and moisture for their germination and growth provided by irrigation. If, owing to miscalculation in the spring, the soil becomes too dry to plow well, water may be applied, although it is considered better to plow when the soil first reaches the proper condition than to allow it to become dry. It is a common practice after this plowing to go over the orchard once or twice with a disk or drag harrow, giving no further cultivation except the necessary furrowing for irrigation until the time for seeding a fall cover crop. Where water is scarce or expensive, irrigation is delayed as long as possible in the spring, and unless the orchard has a permanent cover crop it is the usual custom to water not more than once, if at all, after the fruit is harvested. This is in early summer in the sections of California from which fruit is shipped fresh. This often allows the soil to become too dry for the best development of the fruit buds and fruit for the following year. It also causes a shortening of the growing season, due to lack of moisture in the fall, and consequently a low food reserve for tree development and fruit production. To conserve the moisture after the winter rains and again after irrigating thorough surface cultivation to eradicate weeds can not but prove profitable.

Where there is a hard stratum within reach of the subsoiler with open fertile soil below, subsoiling and blasting to break up this stratum are sometimes practiced with good results. Such soils are rarely suited to growing late-maturing varieties for either shipping fresh or drying for prunes.

IRRIGATION

On account of the semiarid and arid conditions prevailing in nearly all plum-growing sections of the Pacific States, irrigation is looked upon as essential in many districts and highly desirable in all. A large percentage of the area devoted to this crop is now under irrigation. Where thorough tillage is given, however, especially in the cooler sections and where the soil is naturally retentive of moisture, many growers believe that the returns from their orchards would not

XUM

be sufficiently increased to justify the expense of installing irrigation systems. In a few places either insufficient water or tillable land areas too small to be suited for fruit growing make the installation of irrigation systems impracticable.

The method most commonly followed in applying water in irrigated orchards is either flooding, accompanied by checks, or admitting the water to small open ditches or furrows running parallel with the tree rows.

For irrigation where the water passes down slowly or where heavy applications are desired, as in the deep fertile soils used for prunes, flooding is more common than watering in furrows.

Ditches for irrigation are made by furrowing with a plow, and from one to a half dozen furrows are made in the space between rows.

FIGURE 23.—A portion of an Agen (*French prune*) orchard on deep fertile soil which was irrigated in former years but not the current season. The leaves are wilting and dropping prematurely and the trees otherwise suffering from lack of moisture

If moisture moves out freely from the furrows or water is scarce, a furrow on either side of the row is, in some cases, all that is used, but where water is plentiful and the soil such that the water percolates through it slowly more furrows are needed. On hillside plantings a furrow on the uppermost side of each row is sometimes considered sufficient. As the highest concentration of available plant food is near the surface and the soil there is best suited to root growth and activity in absorbing nutrients, the furrows for irrigation should be so close that moisture from one furrow will meet that from the next immediately below the soil mulch. In most soils water goes rapidly downward with but little lateral movement. This movement quickly carries much of the irrigation water below the feeding roots and leaves broad dry areas between the furrows if but one or two furrows are made between tree rows. A considerable portion of the soil is thus utilized but poorly, if at all, by the roots during the dry

summer when the tree should be storing food at its maximum capacity. With bearing trees which have a broad spreading root system, this results in a decided handicap to the tree and consequently affects the profits from the orchard. In making furrows for irrigation, shallow ones are best on shallow or compact soils where the lateral movement of water is slow; but in deep loamy open soils where the root systems are deep and there is a free lateral movement of water through the soil, deep furrows may serve as well and provide easier handling of the water.

The frequency with which irrigation should be made and the quantity of water to be applied depend much on local soil and climatic conditions, the variety of fruit grown, the cultural practices followed in the orchard, and the prevailing price of water. When the

FIGURE 24.—A portion of the orchard shown in Figure 23, which has received moderate irrigation the current season. The better condition of this part of the orchard as compared with the nonirrigated part is apparent

soil is light and well subdrained and water moves rapidly downward frequent light applications are considered better than fewer heavy ones. Soil inclined to be heavy needs water less frequently and in greater quantities. In sections where water is expensive and the supply limited only one application is given in the summer, usually a few days before harvest, if the plums are for the fresh market, so that the fruit may reach the largest size possible. Where there is an unlimited supply of water and the charges for it are low it is often the practice to give frequent and sometimes heavy irrigation. But under this method the soil soon becomes compact, aeration of the subsoil is hindered, and naturally an unthrifty root system develops. Where the soil is deep, moderately well drained, and irrigated water is expensive, as is the case in by far the greater part of the plum-growing sections of these States, it is the usual practice to give moderate irrigations at as widely separated intervals as conditions will

permit. Four or five waterings during the summer are considered by many to be necessary, and weekly irrigations are given by some orchardists where water is inexpensive. Many orchards, however, are maintained in a thrifty condition during the long, dry summers with only two or three waterings, followed by cultivation. (Figs. 23 and 24.)

Irrigation should not be substituted for cultivation to obtain thrifty trees and profitable crops in orchards, but should be resorted to for the purpose of supplementing it in order to maintain the soil moisture at the point of greatest efficiency for tree and fruit development. (Fig. 25.) Most plum orchards, especially those where late-

FIGURE 25.—An Italian prune tree in the nonirrigated rolling section near The Dalles, Oreg., where the summers are hot and dry. An excellent soil mulch is maintained in summer by frequent tillage. In this section the tree tops are thinned out and the branches shortened by annual pruning. The trees are vigorous and productive of excellent large fruit

maturing varieties such as are used for prunes are grown, are located on soils easily tilled and naturally retentive of moisture. For such no definite rule for applying water need be given. The orchardist must judge the needs of his trees by their apparent vigor.

It must be remembered, when considering irrigation, that drying of the soil causes severe injury to the feeding roots and that frequent moistening and drying is decidedly less beneficial to the tree than keeping the soil constantly in good condition, which can be accomplished best by moderate irrigations followed by surface cultivation to destroy vegetation and aid nitrification.

Where an accumulation of alkali endangers the thrift of the tree irrigation water may be used to decided advantage in washing out

and carrying away these soluble salts, provided the soil is of such texture and slope that a good head of water can be forced across the orchard and the excess carried off in drains. In this operation the alkali-laden waters must not be allowed to accumulate in low places in the field, thereby merely shifting rather than removing the trouble.

COVER CROPS

The use of cover crops has become common but by no means universal among plum growers of the Pacific States. The need for these crops in this region is generally recognized, as the soils for the most part are low in organic matter and available nitrates. Since the summer rainfall is light, the development of moisture-retaining qualities is highly desirable. Rank-growing leguminous plants, which will furnish a large quantity of organic matter as well as store nitrogen taken from the air, are always preferred and are the only ones in general use, although the wild vegetation made up of nonleguminous plants and weeds as well as leguminous plants is sometimes allowed to grow in the orchard.

Both perennial and annual plants are grown for cover crops. In the irrigated sections of eastern Washington, eastern Oregon, and Idaho perennial crops are planted almost to the exclusion of annuals, while with but few exceptions annual plants only are used in the sections of Oregon and Washington west of the Cascade Mountains and in California. Among perennial cover crops alfalfa is the one in general use, although red clover is still grown in a few orchards. Alfalfa has been adopted by the larger percentage of plum and prune growers in localities where perennial cover crops are grown.

Where the soils are very fine grained and lacking in humus they become very compact under irrigation and cultivation, and the movement of irrigation water into them is naturally very slow. It is believed the filtration of irrigation water through such soil is decidedly facilitated by the growing of a permanent crop of alfalfa. At the same time, the nitrogen and humus provided by it are much needed and are responsible for increased vigor and production of the trees.

Alfalfa is not always managed as a cover crop when grown in the orchard, but sometimes as an intercrop, although planted primarily for the benefit of the trees. As it is a deep-rooted vigorous plant, it requires a deep fertile soil, such as is commonly planted to late-ripening plums. It not only will not succeed well but will result in injury to the orchard if the soil is shallow. As alfalfa requires large quantities of water, provision should be made for irrigation before the seed is sown, or at least the ground should be leveled and the main lines for irrigation established. Whether planted in newly set orchards or in older ones, a good seed bed should be prepared for the alfalfa. It is a common custom to seed the entire surface, although planting in the areas between the rows is sometimes practiced, especially if irrigation water is not plentiful.

When the alfalfa has made some growth, it is important that the period between irrigations should not be too long. The benefit from the loosening of the soil by the alfalfa roots for the free passage of water is not apparent for the first few months after planting,

XUM

although both the crop and the trees are drawing heavily upon the moisture near the surface during this time.

Water for the alfalfa crop is usually applied in from two to five furrows between rows of trees, the number depending upon the soil type and the ability of the water to pass laterally through it. The applications must be at rather frequent intervals and most often when the alfalfa is making a rapid growth after a harvest. Less water is needed after the alfalfa has reached full growth in orchards where it is not harvested but grown as a cover crop only. To give the quantity of water required for the best growth of the alfalfa may easily result in poor crops of fruit and greatly shorten the life of the orchard. An excess of subsoil moisture in orchards where alfalfa is grown is indicated by small leaves and a lack of vigor in the growth of the wood of the current season and finally by the loss of a tree here and there. On shallow or thin soils the same indications may appear, and on such soils alfalfa should not be used.

Where the alfalfa is not harvested the heavy crop of vegetation for working into the soil supplies an abundance of humus, forms an excellent mulch to protect the surface soil from drying out quickly, and maintains a more equitable temperature for root growth in the surface soil than where frequent cuttings of hay are made or clean culture is practiced. The alfalfa does not require as much water when not harvested as when frequently cut, and where fewer irrigations are necessary there is a more uniform moisture content in the soil. It is often claimed that the water necessary for the plum orchard under clean cultivation equals that where alfalfa is grown but not harvested, while the tree growth and fruit production are decidedly greater. Where cut for hay, a harvest is usually made just as the fruit is ripening, to make fruit picking easier; and where it is allowed to remain on the land, the crop is broken down with a roller or disk or cut with a mower and then worked into the surface soil, so as to be out of the way of the harvesting crews.

Where alfalfa is grown as a permanent cover crop it is necessary occasionally in most places to plow under the old crop and seed a new one. This is due, in part at least, to the alfalfa being gradually crowded out by weeds and grass which grow from seed carried in by irrigation water.

Red clover, when planted for a permanent orchard cover crop, is managed in the same way as alfalfa. On account of its shallower root system the planting of it has been almost entirely replaced by alfalfa. (Fig. 26.)

Perennial cover crops are rarely grown in plum and prune orchards in western Oregon, western Washington, and California, but annual ones are planted or the growth of weeds and other plants that develop without hand seeding is encouraged in most orchards. Vetch, melilotus, and horse bean are the most favored crops for planting in these sections. Oats, barley, or some other small grain is sometimes planted as a cover or soiling crop, either by itself or with vetch to support it in the spring and to prevent its being blown down or lodged by rain. Except for the purposes just mentioned, small grains and grasses are not recommended as cover crops in the plum sections of the Pacific States if leguminous or other

more suitable plants can be grown successfully. Bur clover is among the most commonly grown plants adapted to a wide range of soils and well suited to the climatic conditions of the plum-growing regions of California. It is a vigorous grower, easy to manage, a very satisfactory cover crop, and may be plowed under during the spring like other annual cover crops. To perpetuate it without the expense of reseeding, occasional plants are allowed to remain undisturbed, or the tips are left uncovered when plowing. These blossom and ripen seed, which remains in the ground for growth the next fall.

Annual crops are sown late in the summer, sometimes immediately after the first fall rain, or, if rains are late, after an irrigation. To insure quick germination the seed is often sown on the surface and not worked into the soil. If covered, a portion of the seed may not

FIGURE 26.—Red clover as a cover crop in an Italian prune orchard in Idaho

germinate until the following spring, possibly too late for the plants to make a satisfactory growth before plowing. After seeding no further attention is given the cover crop, as the fall and winter rains are usually sufficient for a good plant growth. When the winter and early spring temperatures are moderate, a good growth is usually made by the cover crop; but if the growth has been slow, spring plowing is sometimes delayed for a few days after the soil has become sufficiently dry for plowing to permit the growth of the cover crop. This practice, however, is often attended with injurious results.

A poor growth of the cover crop is often noticed in old orchards where clean cultivation has been practiced for a number of years and in localities where the soil is lacking in available nitrogen. A number of places have been observed where the growth was exceedingly poor except in portions of the orchard where stable manure or commercial fertilizers had been applied. In those places a rank thrifty growing crop was found.

INTERCROPS

Intercropping is often practiced in plum orchards on high-priced land. Among annual crops beans, corn, pumpkins, and garden crops are planted extensively, usually profitably, even where the soil is of only moderate depth, if water is plentiful and good soil management practiced. Where such crops are grown the results indicate that they are decidedly preferable to small grains and grasses. Aside from alfalfa, the perennial crops used for interplanting with plums include hops, walnuts, other deciduous fruits, and berries. (Figs. 27 and 28.) Each of these crops is confined to a more or less restricted set of conditions, and all need fertile soils. Hops are sometimes planted at the same time as the prune trees, or if prunes are planted in the hop field, the hops are allowed to remain until the

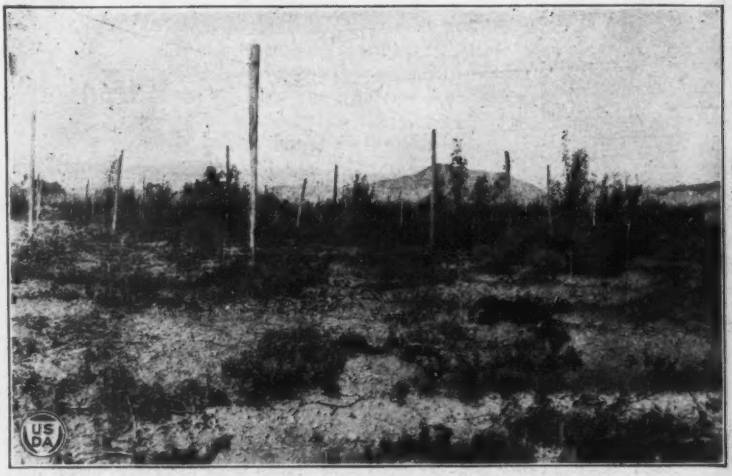


FIGURE 27.—A 2-year-old Agen (*French prune*) orchard interplanted with hops in California. The hop harvest had just been completed

trees are a few years old. The time for removing them depends on the relative value of the two crops, but they should not be left longer than four or five years after the prunes are planted. This practice is most common in some of the warm valleys of California, where a substitute for hops is sought. Where Persian walnuts are planted with plums it is usually the plan to remove the plums when the walnuts have come into bearing. This plan is also followed with other deciduous fruits, but sometimes both crops are planted with a view to deciding which shall be the permanent orchard when both have come into bearing. The use of vegetables and berries as intercrops is usually discontinued when the plum trees approach full bearing.

PRUNING

At the time of setting in the orchard, the nursery tree, which is usually a whip, is cut back to a bud where the uppermost branch for forming the head is desired. This height varies greatly with differ-

ent growers and with the variety and the purpose for which it is grown. With those grown for their fresh fruit, 2½ feet is about the height preferred for cutting back the young tree, particularly those which are most inclined to be upright in growth, such as most Japanese varieties. The same height, or even a lower head, is favored by growers of the Agen (*French prune*), especially in California. In States farther north, where the Italian prune, a comparatively spreading tree, is the important variety, the nursery tree is cut back to a height of 3 to 3½ feet or even more for the formation of the tree head. (Fig. 29.) The height at which the branches are to be produced should be determined by the habits of the variety (whether spreading or upright), by the implements to be used in cultivation, and by the disposition to be made of the fruit. If the fruit is for

FIGURE 28.—A young Agen (*French prune*) orchard with an intercrop of winter cauliflower. (Santa Clara Valley)

fresh shipment, low branches make the harvest easier; but for growing prunes, where the fruit is shaken from the trees, the formation of the tree head may be somewhat higher without particular disadvantage except that the danger of injury by sunburn on the trunk is increased.

Three branches are usually desired for forming the lower framework of the tree, although some growers prefer four or five. These branches are selected from among those growing from the upper part of the trunk, care being taken to select strong branches separated by several inches along the trunk and at distances as nearly equal as possible around it.

Where these main branches are allowed to grow near the same point on the trunk, a pocket which will hold water and collect dust, falling fruit, and leaves is often formed within a few years by the increasing diameter of the branches. This makes an easy entrance for wood rots, resulting in the loss of many limbs and the weakening

XUM

of others, so that they are easily broken down by heavy loads of fruit or by windstorms. Where four or five main branches are allowed to grow in forming the tree, the danger of the formation of such a pocket is obviously increased. (Fig. 30.)

To induce further branching of the young tree, the limbs which develop the first season after the tree is planted are, in turn, cut back the following winter, or they may be lightly pinched back during the summer when they have reached the desired length. The same practice is followed in succeeding years to induce further branching.

Superfluous branches should be rubbed off when they first appear, or they should be removed not later than the winter after their first season's growth. In selecting the branches which are to remain, much can be done toward directing the shape of the tree and developing a formation that will enable it to hold heavy crops of fruit.

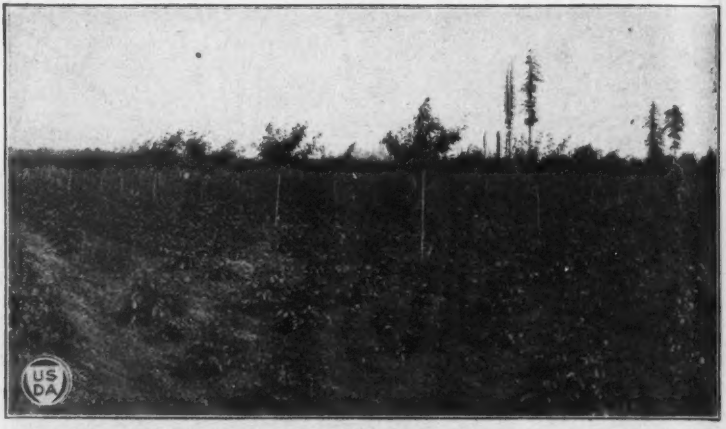


FIGURE 29.—High-headed Italian prune trees in an orchard intercropped with potatoes. (Clark County, Wash.)

Where too many branches are left or some have grown at an undesired angle they may be removed, so as not to interfere with the best development of the tree.

With top-grafted trees, much can be done toward establishing the framework the first year, as at this time the new wood makes a vigorous, rampant growth and may be pinched back three or four times during the summer, thus establishing as many points of branching. (Fig. 31.) Such pinching back causes the growth of a great number of branches, and those not needed may be removed when they appear or may be left until the regular time for pruning during the dormant season.

Many have followed the custom of severely heading back all varieties of plums each winter until a considerable production of fruit is reached, in order to favor the development of a stocky vigorous tree, but this system is being gradually abandoned except for the first year, after which the branches are only thinned out or cut to laterals to form a more open tree. In this way the young tree

makes a greater growth and comes to bearing earlier than where severely cut back each winter. The practice of cutting back to laterals and removing only superfluous branches is coming into more general favor on irrigated lands where soils are fertile and a thrifty new growth is assured. The old method of pruning is still used in some sections, especially in nonirrigated orchards where new growth is slow and for some varieties which are spreading in their habits of growth, grow slowly, and are not naturally vigorous.[8]

In the pruning of bearing trees there is considerable divergence in practice. With varieties grown for prunes the branches, as a rule, are thinned out rather than cut back, and in many instances no pruning is performed or only dead branches removed. Where grown for the fresh fruit, more thinning out is done with many varieties, especially the Japanese sorts, and in some sections severe annual cutting back is customary. On the thinner and poorer soils and in nonirrigated sections the practice of cutting back the 1-year wood is more general than elsewhere. Methods favored or particularly successful in one locality are naturally carried into neighboring ones, although conditions for wood growth there may be decidedly different and poor results may follow. The annual wood growth is normally short on the drier soils; on all but the deeper soil types in such places varieties for the production of fresh fruit are grown. Good prices for the fruit can be realized on large sizes

FIGURE 30.—A plum tree composed of several main limbs which started from points close together on the trunk. As the limbs increased in size a pocket was formed where they came together. Wood-decaying organisms found entrance here, thus weakening the limbs, some of which have broken down

[8] For further information on this subject, see the following bulletins:
Tufts, Warren P. Pruning young deciduous fruit trees. Calif. Agr. Exp. Sta. Bul. 313, p. 111–153, 24 fig. 1919. Literature cited, p. 150.
Kraus, E. J., and Kraybill, H. R. Vegetation and reproduction with special reference to the tomato. Oreg. Agr. Expt. Sta. Bul. 149, 90 p., 22 fig. 1918. Literature cited, p. 87–90.
Morris, O. M. Prune growing in western Washington. Wash. Agr. Exp. Sta. Pop. Bul. 120, 21 p., 7 fig. 1920.

XUM

only, and severe cutting back of the previous season's wood growth is relied on to insure large sizes of fruit. In some dry places where the annual growth is normally short, even on heavily pruned trees, if cutting back is not practiced it will be exceedingly short after a year

FIGURE 31.—Three-year-old President plum grafts top-worked on a peach tree. The new plum growth was pinched back three or four times during the first season after grafting. This caused the growth of many branches that season, some of which should be removed

or so, and poor production and lack of vigor in the tree may be expected.

On irrigated soils which are considered insufficiently deep for planting to varieties for prune making, but where plums for fresh

shipment are grown extensively, cutting back the new wood is widely practiced. Under these conditions some growers cut back lightly the growth of the previous year and with varieties of the domestica group confine their pruning mostly to the thinning out of branches. With the Japanese plums, which are naturally vigorous growers and bear their fruit on spurs on wood of all ages, more cutting back of 1-year-old wood, as well as the thinning out of branches, is practiced, to insure a vigorous wood growth and large-sized fruit. In this instance, pruning is used partly as a means of thinning the fruit or, rather, of reducing the crop and distributing the load over the tree. Where heavy cutting back is practiced the trees are called upon to produce a crop of both wood and fruit. The soil can not be expected to sustain a profitable orchard where the toll for each is heavy.

Trees of the Agen and Italian prune, the two principal varieties grown for prune production, bear most of their fruit on wood 1 and 2 years of age. A thrifty wood growth should therefore be made by the tree each year. If not thinned out or occasionally cut back the twigs soon become too numerous for the tree to produce a satisfactory terminal growth, and a poor terminal growth results in small or irregular crops of fruit. On the other hand, removing too much bearing wood will naturally prevent a good crop the following year. Under conditions most favorable for wood growth by varieties which naturally make a strong growth, less thinning out of the twigs will be necessary. Where thinning out the branches and occasionally cutting the terminal growth back to laterals is not sufficient to induce the growth of several inches of vigorous new wood at the ends of the twigs during the summer, a change in methods of culture should be resorted to for stimulating more vigorous growth.

The growing and fruiting habits of the individual varieties should be closely observed and should guide the pruner in his work.[9] Varieties inclined to make a compact upright growth, such as the Santa Rosa or Wickson, should be pruned to induce spreading. Those naturally spreading, such as the Burbank, should have their long lateral-growing branches shortened to facilitate cultivation and to encourage the growth of strong upright branches which can carry a heavy load of fruit and provide shelter from the sun for the main trunk. Varieties which bear fruit on spurs on older wood should be kept open for the admission of sufficient light to develop fully the foliage of such spurs. This can be accomplished best by moderately thinning out the new wood. Severe cutting back will result in a vigorous new growth, which tends to shade and prevent spur development. Too little pruning, on the other hand, often results in the stagnation of growth of these spur-forming varieties, with consequent poor production. Excessive pruning of the upright-growing varieties of Japanese plums causes a rampant growth and a tendency to form long barren poles, on which fruitfulness is delayed, even if spurs form on them at all. Among varieties which under good growing conditions make some terminal growth on which they bear most of their fruit the following year there are variations in tendencies which should not be overlooked in pruning. Excessive cutting back

[9] For information on this subject, see U. S. Dept. Agr. Bul. 1477, Varietal Characteristics of Plums in the Pacific States in Relation to Pruning. 1927.

will cause a heavy new growth with these as with other varieties, while no pruning tends to cause the formation of spurs and inactivity of growth of such spurs. This occurs at least on varieties or individual trees where little or no terminal growth is made, with a resulting decrease in fruit production. With the dying out of some spurs and the loss of others broken off in harvest and cultivation, the fruit-producing portion of the tree is seriously reduced year by year. This is naturally most apparent where the orchards are on poor soils or where there is a shortage of soil moisture.

With some varieties a short terminal growth with occasional branching continues without the formation of spurs or any upright vigorous growth, and gradually long, slender, drooping masses of unfruitful twigs will develop. Trees of the Italian prune often illustrate this. These differences in habits in the growth of wood and fruit spurs may be well illustrated by the Agen and Pond varieties, and by the Giant, which is a cross between them. The Agen variety, if left unpruned, will continue the growth of all its branches with a gradually shortening annual wood growth, and at the same time the fruit gradually will decrease in size, provided good crops are matured. When left unpruned the Pond will quickly stop its terminal growth. The dying out of many spurs and the poor leaf growth of others exposes the fruit and wood to the sun, often resulting in sunburning. The Giant, although losing some of its spurs, will continue a fairly vigorous growth of all its terminal branches and twigs and produce a good crop of normal-sized fruit.

It should be remembered in all pruning that the work should be carefully performed with sharp tools. Where a wound is made which will not heal over quickly, as when a stub is left that is too long, or split branches are not removed, or where the bark is torn or a wound left by the removal of a large branch, there is danger of the entrance of wood decays. The careful selection of branches when shaping the young tree and later in pruning, so as to make unnecessary the cutting out of large branches, and the careful manipulation of pruning tools will prevent serious losses later.

FRUIT THINNING

Thinning the fruit is often important in plum culture. It is seldom practiced where the fruit is grown for prunes, but many varieties cultivated for their fresh fruit require it. Thinning is done primarily for the purpose of allowing the fruit which remains on the tree to become larger, so that higher prices may be received for it, but thinning also relieves the tree of some of its weight and tends to prevent the breaking of branches and to reduce the number of crops required, thereby better enabling the tree to bear regular crops of fruit. Pruning out superfluous twigs during the dormant season and also after the fruit has set is a cheap and efficient means of decreasing the load of fruit, but hand thinning, in order to leave the fruit properly spaced on the tree, is often necessary. Hand thinning should be done as soon as all danger of spring frosts is over, so that the tree may be relieved of its excessive burden as early as possible.

Thinning is necessary almost every season with some varieties of the Japanese group, such as Beauty and Burbank, and is less so or not at all necessary with many varieties of the domestica group.

PROPPING AND BRACING

Artificial supports are often necessary to prevent the breaking down of fruit-laden branches. Slender boards are used for this purpose and are put in place when the branches start to bend with their burden of fruit.

Wires to fasten opposite branches together, thus preventing their being broken by loads of fruit, are used in a number of orchards. This means of support is considered by many a satisfactory substitute for the use of wooden props. A number of methods of using wire for supporting branches are employed, the most common being to fasten a small wire to the large branches and connect them to a ring in the center of the tree. If it is not convenient to fasten the outer branches to the center ring they may be wired to a branch which has been given support. Connecting the outer branches with a wire without the use of a ring in the center is a method favored by some.

The use of wire supports has the advantage of requiring but a small outlay for material, is fairly permanent, and does not interfere with cultivation, irrigation, and fruit picking, as do wooden props. There is often loss of branches by breaking where props are loosened and fall when strong winds sway the trees. This is avoided by the use of wires.

Where weakness is found, due to an unsatisfactory crotch, or where a large limb has been partially split down, long bolts put through the trunk or limb have been used for giving permanent support.

The necessity of branch supports may be partly eliminated by pruning, so that wounds will heal quickly and in a manner to develop a strong framework, by thinning the fruit, and by preventing injuries to the tree from sun scald and diseases which cause wood decay.

FERTILIZERS

Wherever animal manures have been applied to plum orchards in the Pacific States excellent results have followed. Owing to the shortage of such fertilizers, however, comparatively few orchards have been so treated. Quickly available forms of nitrogen have been used in a number of instances to cause a heavier setting of fruit. For this purpose fertilizer is broadcast about the trees three or four weeks before the blossoms appear. Many growers claim that decided benefits have followed this treatment.

FRUIT HARVEST

The plum harvest starts as soon as fruit enough to warrant a shipment reaches sufficient maturity to ripen while in transit to the market. This is late in May for the earliest varieties in some sections of California. The harvest of other varieties continues until August in that State and until late in September in some places in Washington where summer temperatures are lower. With some of the Japanese varieties, the fruit of which is very juicy and therefore easily bruised, little delay can be allowed for harvesting after the fruit reaches shipping condition. Many of the domestica varieties, however, have a texture which enables them to become nearly

ripe on the tree and still reach distant markets in good condition.[10] Fruit that ripens slowly in sections where summer temperatures are moderate or low is sometimes allowed to remain on the tree for a period after reaching maturity, without injuring it for market.

Under average conditions plums ripen unevenly over the tree. Therefore two or three pickings must be made, although one or two may be sufficient for varieties where the fruit is allowed to become well ripened before picking. Harvests are usually three or four days apart, but this period is determined by weather conditions and the variety.

As badly bruised fruits and those with broken skins are not suitable for shipment, care must be exercised in picking and packing the fruit. In harvesting, the pickers take the fruit from the tree by hand and place it in baskets or buckets for hauling to the

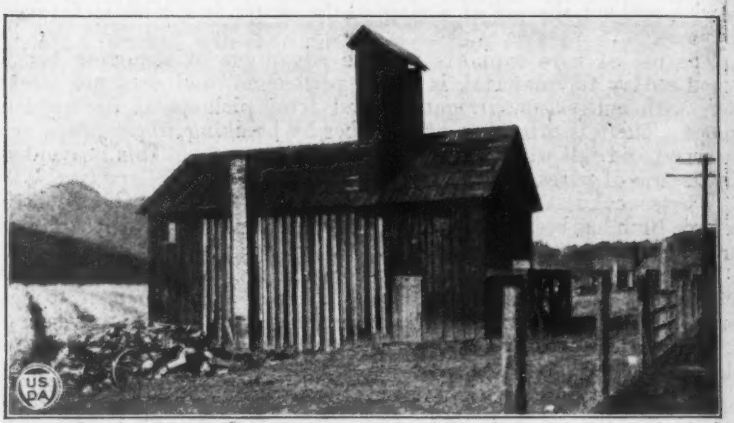


FIGURE 32.—A 3-tunnel drier typical of those used by many prune growers in the Northwestern States

packing house. Light ladders are used for reaching the fruit on the tall branches.

In the packing shed where the fruit is to be graded by hand it is very carefully poured into bins on packing tables, where it is sorted to size and defective plums are removed as the fruit is placed in the containers for shipment. This sorting requires considerable time, and often much of the bloom that covers the plums is rubbed off, seriously detracting from the appearance of the fruit. Excellent packages, however, are often put up where the grading is done by hand. Machines for grading plums to size rapidly and with but little if any serious bruising have come into common use.

For shipping the fruit a crate holding four tin-rimmed veneer baskets is the container most commonly used in California, although crates, fruit boxes, and lug boxes of different sizes are also used. A container called a "suitcase," holding about 18 pounds of fruit, is commonly used in the Pacific northwest.

[10] See Calif. Agr. Exp. Sta. Bul. 428, The Relations of Maturity of California Plums to Shipping and Dessert Quality. 1927.

As a rule, each orchard or farm has its own packing house, which is conveniently situated in or near the orchard where the fruit is packed and loaded on trucks for transporting to the shipping station, although a number of packing houses designed for packing fruit from several orchards are operated during the fruit-packing season.

Laws regarding the quality of fresh fruit and the shipping containers are operative in each of the Pacific States and enforced by county, district, or State officials.

The prune harvest is more cheaply and quickly accomplished and with less care than is the plum harvest. The fruit is allowed to remain on the tree until it is thoroughly ripe and is falling off of its own accord. Where jarring is necessary to cause the fruit to fall, it is done by striking the branches with poles. The fruit is gathered

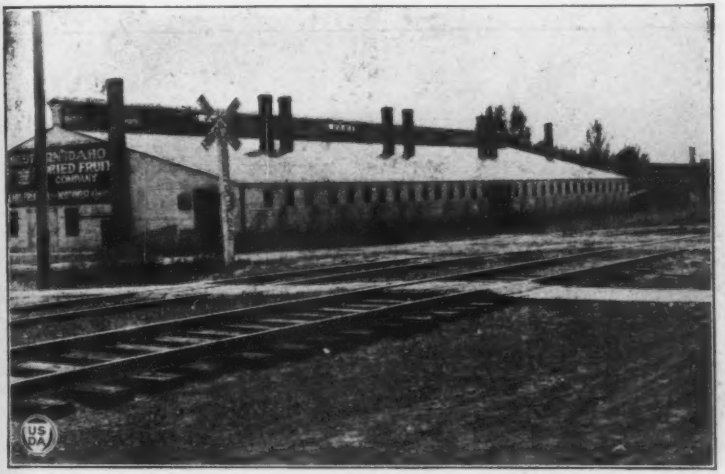


FIGURE 33.—A modern large-capacity prune drier and processing house combined. (Idaho, 1921)

by hand from the ground or canvas on which it falls and is placed in lug boxes for hauling to the drying yard.

Owing to natural humidity and fall rains, the entire output of prunes in Washington, Oregon, and Idaho must be dried artificially. In California the period during which prunes are dried is usually hot and dry, and almost the entire output is cured in the sun. (Figs. 32, 33, and 34.) During recent years artificial evaporation has come into considerable prominence here as an insurance against the loss of fruit from rain. This method of drying is more expensive than open-air drying, but in case of early fall rains it enables the grower to dry his crop without the loss of fruit. It also permits the use of dry yards for orchard or other purposes. After drying, the fruit is taken to the processor, where it is prepared for market.

Those interested in the details of prune drying should consult Department of Agriculture Bulletin 1141, Evaporation of Fruits.

DISEASES AND INSECTS

A number of diseases and insects attack the plum and prune in the Pacific States. They are amenable to control or preventive measures, with which the grower should become familiar in anticipation of having eventually to make use of them.

The principal diseases include brown rot, which causes decay of the fruit and may affect the small twigs and spurs, or even the blossoms; leaf spot and shot-hole fungus, which attack the leaves; and heart rot and oak-root fungus, which attack the tree. Other diseases may occur, but those mentioned are usually the most common.

The diseases affecting the fruit and foliage are held in check by spraying; those affecting the woody parts of the tree are subject to preventive methods only.

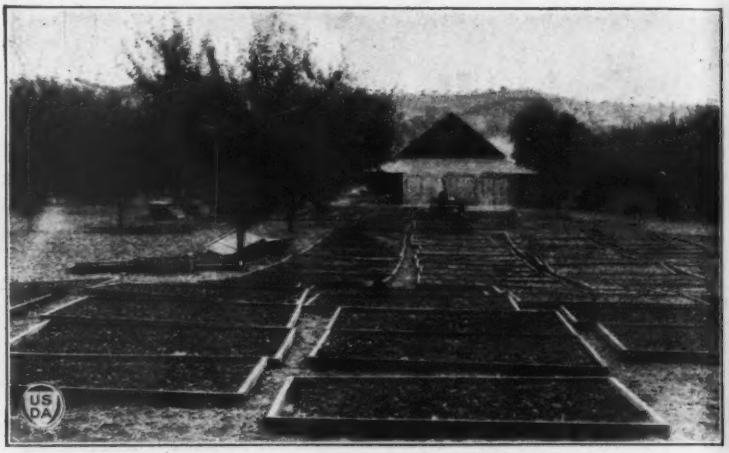


FIGURE 34.—A prune-drying yard in central California

Heart rot is a rather general term commonly applied to the results of wood-decaying organisms which find entrance to the heart of the tree through long stubs left in pruning, bad crotches or pockets resulting from improperly formed tree tops, or wounds made in other ways. Preventive measures consist obviously in avoiding or eliminating those means through which the fungi causing decay enter the tree.

Oak-root fungus is common on roots of oaks indigenous to some of the fruit districts of the Pacific States. The roots of many fruit trees are likewise susceptible to this disease. Where it occurs the only practicable course is to leave the infected areas unplanted or to plant pears propagated on French roots or figs (where these fruits are adapted), since these are about the only fruits resistant to this disease. California black walnuts are sometimes planted in such instances, to be top-worked later to the Persian walnuts.

Among the most destructive insects which attack plums and prunes in the Pacific States are the peach-tree borer, San José scale, red

spider, thrips, twig borer, brown apricot scale, and black scale. These, with a few of less general importance, cause heavy losses annually to the plum and prune producing industry.

As climatic and other conditions vary greatly in different regions and localities, the plum grower should apply to his State agricultural experiment station for advice regarding preventive and remedial measures to be employed for the control of injurious insects and diseases with which he is likely to have to contend. Information may also be obtained from the United States Department of Agriculture.

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PLUM and PRUNE GROWING in the PACIFIC STATES

XUM

IN ITS VARIOUS FORMS the plum is more widely distributed throughout the country than any other tree fruit, though in value the plum crop is exceeded by that of four other fruits—the apple, peach, orange, and grape. The great range of distribution, however, is mainly incident to the great diversity that occurs in the species of native wild plums, cultivated horticultural varieties of which are found in almost every nook and corner of the country.

Though the native plums give vastness in range of plum culture in general, it is the domestica or European varieties, the Japanese sorts, and those that have originated as hybrids between Japanese and native plums that constitute the commercial industry. Prunes are included in the domestica or European group. Some of the Japanese and hybrid varieties are grown very widely, possibly as widely as the varieties of any one species of native plum.

Though this bulletin is regional in its direct application, it has to do with a very large part of the plum and prune industry, as practically two-thirds of all the plum and prune trees in the country are in California, Oregon, Washington, and Idaho.

Washington, D. C.

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PLUM AND PRUNE GROWING IN THE PACIFIC STATES[1]

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CONTENTS

	Page		Page
Plum and prune growing regions	1	Stocks used in propagating plum trees	24
San Francisco Bay and central California coast counties	3	Top working	26
Interior valleys of central California	4	Distance for planting	35
Western Oregon and western Washington	7	Nursery trees for planting	36
Eastern Oregon, eastern Washington, and Idaho	9	Time for planting	36
Choice of locality and site for a plum orchard	11	Orchard culture	37
Soils	11	Irrigation	39
Climatic conditions	13	Cover crops	42
Site and location	16	Intercrops	44
Varieties	18	Pruning	46
Varieties of plums and prunes in the Pacific States	20	Fruit thinning	51
Pollination	23	Propping and bracing	51
		Fertilizers	52
		Fruit harvest	52
		Diseases and insects	55

PLUM AND PRUNE GROWING REGIONS

THE AREA which may be utilized for the culture of plums and prunes in the Pacific States is very much limited when compared with the gross area of these States, as orcharding is restricted to tillable lands that are under irrigation or to locations where the winter rainfall is sufficient for the needs of the trees.

These requirements have resulted in limiting the commercial growing of this crop to certain sections, although in those sections plums and prunes are among the most important fruits produced. These sections, widely separated in distance and in climatic conditions, are discussed here separately as far as possible. Natural geographical

[1] In this bulletin the plum and prune are considered one fruit, and botanically the European or domestica plum and the prune belong to the same species, *Prunus domestica*. The cultural methods are the same, but the methods of harvesting and handling the fruit are or may be different, depending on the use to which the fruit is put. The use of the terms "plum" and "prune" dates back for several centuries. The words come from different sources, one being Anglo-Saxon, the other French. Originally they doubtless were synonymous in meaning. At what date the term "prune" was first used to designate a "dried plum" or a plum capable of being dried into a product having certain desirable characteristics is uncertain; however, this term has come to signify a plum which is capable of being dried without fermenting when the pit is not removed. The term also signifies the dried as well as the fresh fruit. A prune, therefore, is substantially a variety of plum which possesses certain peculiar characteristics. Most plums, if dried with the pits remaining in them, would ferment in the process. Prunes, in the fresh state as compared with plums, possess a firmer flesh, a higher content of sugar, and frequently a higher acid content; in other words, a prune is a plum having these characters in a more marked degree than other plum varieties. Large quantities of fruit which could be dried to prunes are sold in the fresh state; they are then handled in the same way that plums are handled. Plums are sometimes dried after the pits are removed, but the product is called "dried plums," not "prunes." In case of varieties that can be dried to prunes, the fruit in the fresh state, as indicated above, is often called a prune; and in some instances the word "prune" is a part of the variety name, as the Italian Prune or German Prune.

XUM

divisions are used for boundaries of the regions where phases of the industry, such as marketing and cultural methods, differ sufficiently to warrant separate consideration.

The boundary of each of these regions to which some phase of the industry is peculiar is determined largely by prevailing temperatures, although, within a given region, soil conditions and the availability of water for irrigation result in considerable divergence in methods of carrying out details in orchard management. Although this crop (plums and prunes considered collectively) may be found in home orchards of all sections of the Pacific States, four geographical districts may be said to include the principal commercial producing areas of this fruit. These are (1) the San Francisco Bay and central California coast counties, including the Santa Clara, Napa, and Sonoma Valleys and their tributary valleys and adjacent foothills; (2) the interior valleys of central California, including the Sacramento, San Joaquin, and tributary valleys, and the bordering slopes and foothills; (3) the principal river valleys and the adjacent rolling lands of western Oregon and western Washington, including the Willamette, Columbia, and Umpqua River Valleys; and (4) the irrigated valleys of southeastern Washington, northeastern Oregon, and the Snake River Valley region of Idaho. With this last section is included also the region of east-central Washington and the bordering portion of Idaho known as the Palouse region, which lies in the same geographical district as southeastern Washington, although cultural practices differ decidedly in the two sections.

Plums are grown commercially also in southern California, principally in Los Angeles and Riverside Counties, but here they are not among the more important fruit crops. In the four divisions specified there is produced almost the entire commercial output of plums and prunes in the Pacific States, although the plum is widely planted for home use, and a large list of varieties is represented in the home orchard in all fruit-growing localities of these States.

In each of the four main districts some phase of plum culture is practiced which is for the most part distinct from that of the other districts, these differences being made necessary by the peculiar climatic conditions of the district. The main features in the culture of this crop that are peculiar to each district may be summarized as follows:

(1) The San Francisco Bay and central California coast counties include the principal centers in this country for the production of the Agen, commonly called the French prune or Petite prune, and of the Imperial Epineuse prune. In this district these varieties are grown in far greater quantity than all other varieties combined, and owing to the warm, dry fall climate the crop of prunes may in most seasons be dried in the open air. The larger portion of the orchards in this district is under irrigation.

(2) The interior valleys of California produce plums both for shipping fresh and for making into prunes. Practically all the varieties of plums and prunes grown in the Western States are represented here. Most of the acreage in this district is under irrigation.

(3) In western Washington and western Oregon the Italian Prune and the Agen are the only varieties of wide commercial importance among the rather small list grown, the Italian Prune being decidedly the more important of the two. The entire output of prunes is dried by artificial means. Practically all the orchards of this district are grown without irrigation.

(4) In the district east of the Cascade Mountains, including southeastern Washington, northeastern Oregon, and Idaho, the Italian Prune is by far the most important variety, almost the total crop being shipped fresh to distant

markets. The entire acreage in this district is under irrigation except in the Palouse region, where the Italian Prune is the only commercial variety and all orchards are maintained by dry-farming methods. The fruit in the Palouse region is usually dried into prunes by artificial means, but some fresh fruit is shipped to distant markets.

For convenience in describing the commercial distribution, the prevailing cultural practices, and the economic conditions in plum culture, the district above-mentioned are considered separately.

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES

The first district includes the cultivated areas of the Santa Clara, Sonoma, and Napa Valleys and their tributaries, or the valley areas of Santa Clara, San Mateo, San Benito, Sonoma, and Napa Counties.

FIGURE 1.—Orchard of Agen (*French prune*) prunes growing in a fertile valley soil, Healdsburg, Calif.

Varieties for prune making are grown throughout these valleys and to some extent throughout the adjacent lower slopes and foothills, with centers of production near San Jose, Napa, and Healdsburg. A few plums for the fresh market are grown here, and a few are grown for canning (fig. 1).

Since 1875 plum and prune planting in this district had gradually increased up to a few years ago, except for a few interruptions due to low prices of the product. During the past few years new plantings have been light, and almost all of the orchards are now in bearing.

The Santa Clara Valley, the first center of the prune industry in this country, is still the principal center of production, with more than half the prune trees in the district, mostly in Santa Clara County. Nearly one-fourth of the prune trees in this district are in Sonoma County.

XUM

The soils devoted to plum and prune production in these valleys are, for the most part, the deep fertile loams and sandy loams which are darkened by a moderate humus content and are easily handled, productive, well-drained, and enduring in nature. Small areas of adobe soil are found, and in certain sections the soil moisture becomes excessive in some years, requiring drainage for the most satisfactory tree development. The summers are long and warm, and, as in all fruit-growing sections of the Pacific States, the summer rainfall is exceedingly light through the plum-growing season. Irrigation is practiced wherever water is available and facilities for its application have been provided. During the period for drying fruit, in September and early October, occasional interruptions are caused by rains, which make it necessary to stack the drying trays, and even with this precaution loss of fruit is not always avoided and is sometimes considerable. With ordinary caution, however, in most years the crop may be dried in the open with but little, if any, loss. As an insurance against damage by rains, artificial driers were introduced a number of years ago, and now about one-half of the crop is dried artificially. The temperature throughout the prune-growing sections of this district is very much the same through the fruit-growing season, except that the daily range is somewhat greater during the warmest part of the summer in the portions of the main valleys which are farthest from San Francisco Bay.

Aside from the Agen, which is the principal variety in all sections of this district, the Imperial Epineuse is grown to a considerable extent in the Sonoma Valley, especially in the plateaus bordering the valleys near Healdsburg. Throughout the district the Sugar and the Standard are varieties of some importance. The culture of plums for shipping fresh is not an important industry here, mainly owing to insufficient warmth during the early summer to ripen them so that they may be marketed in competition with the plums from sections where they ripen earlier. In some localities of this district there is also a lack of water for irrigation, which is needed to produce fruit of the larger sizes suitable for shipping.

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

The interior valley district includes the Sacramento and San Joaquin Valleys of California and their bordering slopes and tributary valleys. Plantings, which total more than 5,000,000 trees, are found in all localities of this district where plums and prunes are cultivated, with three-fourths of the plantings in the Sacramento Valley. The largest centers of production are the Loomis-Auburn section of Placer County, the vicinity of Vacaville in Solano County, the Hood-Walnut Grove section of Sacramento County, in Tulare County along the Feather River in Sutter County, and near Chico in Butte County. One-third of the plum trees in this district are in the two first sections mentioned. Fresno, San Joaquin, and Kern Counties also have a large acreage devoted to this fruit, and all other counties of the district include it among their fruit crops.

The plums that ripen first in the Pacific States are produced in the plum-growing sections of this district where there are extensive

plantings of early-maturing varieties. The first harvests are made in the southern end of the San Joaquin Valley near Bakersfield and a week or so later in the foothills of Solano County, near Vacaville. Fruit of the earliest varieties is shipped to eastern markets during the latter part of May. The harvest in the foothills of Placer County starts but a few days later and is followed closely by that in the sections throughout the main valleys.

While the low winter temperatures are approximately the same throughout the district, the localities where the earliest fruit is produced are naturally protected in the spring from the cool, moist breezes, which sweep through the main portions of the lower valleys, and their surface soils are well-drained and friable, and absorb heat well. These conditions result in the early blossoming of the trees and the rapid development of the fruit.

Plums both for fresh shipment and for prune making are grown extensively in all the fruit-growing centers of the district except in Placer County, where the entire output is fresh fruit, and in the Hood-Walnut Grove section, where almost the entire output is fresh

FIGURE 2.—A plum orchard on delta land in the lower Sacramento Valley, Calif. Note the close planting and vigorous growth of the trees. A small portion of the river levee is shown at the left.

fruit. Aside from these localities, which are the most important sections in California for the production of plums for fresh shipment, the Vacaville section is the center of heaviest production. Over nine-tenths of the plum trees of this district are of bearing age. Vast areas suitable for this fruit are now occupied by annual crops or are not under cultivation, a result largely of the lack of irrigation systems.

The soils devoted to plum culture in this district are those of the deep, fertile, alluvial types in the valley bottoms (fig. 2). In the higher lands there is a wide range of type varying from heavy deep loams to sandy and gravelly soils, where the underlying stone is sometimes covered with only a shallow layer of tillable earth. Soils underlaid near the surface by hardpan, which occupy broad areas in the main valleys, are avoided almost entirely for varieties for prune making and are naturally unsuited to varieties for fresh shipment. Soils derived from granite and some types of sandstone, such as are sometimes found in the rolling foothills bordering the large valleys,

XUM

are fertile and well-drained and are in demand even where the stratum of tillable soil is not deep.

Notable among the nonirrigated sections is the rolling area near Vacaville, in Solano County (fig. 3), where the foothill soils are derived from and underlain with sandstone. If properly tilled, these soils are sufficiently retentive of moisture to produce profitable crops of fruit without irrigation. As no water is available for irrigation in this section, dry-farming methods are practiced, and the earliest ripening fruit is grown.

In this district the summers are long, hot, dry, and well suited to the early ripening of plums as well as for the satisfactory development of prunes. As a rule the summer drought continues well into the autumn, so that prunes may be dried in the sun without loss from fall rains. However, the fear of damage by fall rains has resulted in the construction of dehydrators, which now care for the

FIGURE 3.—Plum orchards on the rolling lands near Vacaville, Calif. The season's earliest fresh-fruit shipments to eastern markets are made from orchards on these lands.

drying of a part of the crop. The early warmth in the spring causes the trees to blossom early, and some injury by frost, at least to the early blooming varieties, is not uncommon in the lowlands. Here the annual rainfall varies considerably from year to year, but there are no rains during the fruit-growing season. Irrigation is therefore imperative in the shallower soils and highly desirable on the deeper valley soils not moistened by subirrigation. In some places in the Hood-Walnut Grove section of the lower Sacramento Valley, orchards are usually plentifully supplied with moisture by subirrigation.

As in the valleys near the coast which have just been discussed, the Agen variety is by far the most important for prune making, although orchards of the Imperial Epineuse, Standard, Sugar, Sergeant (*Robe de Sergeant*), and a few others are occasionally found. Almost all varieties of plums grown commercially in the Pacific States for fresh shipment are found here in considerable quantities.

WESTERN OREGON AND WESTERN WASHINGTON

The principal commercial plum-growing centers of western Oregon and western Washington lie in the cultivated areas between the Cascade and Coast Ranges in western Oregon and west of the Cascade Mountains and the Puget Sound section of Washington. Until the late eighties plum growing was a minor industry in this district, but about that time it became popular and most of the older orchards were established. Plantings had not greatly increased until within the past 20 years, when many orchards have been established or old ones enlarged.

The principal sections where plums are found are in the vicinity of the Williamette River in Polk, Marion, and Yamhill Counties, with centers near Salem, Dallas, and Newberg, and in the Roseburg-Riddle section of the Umpqua River Valley in Douglas County, where the plantings are about the same in extent as in the different counties

FIGURE 4.—A prune orchard in bloom in a rather narrow valley location, Umpqua Valley, Douglas County, Oreg.

farther north just mentioned. More than three-fourths of the prune trees in western Oregon are in these four counties.

In western Washington the principal plum-producing section is the Vancouver-Camas-Washougal section of Clark County.

The greater portion of the orchards in the Umpqua Valley are in the bottom lands near the river, while in the Willamette River Valley region the rolling lands have been as much favored as the low valleys for prune production (fig. 4). Many growers have given preference to the broken, rolling lands which reach 500 or more feet above the river bottom (fig. 5). In the prune-producing sections of Washington just mentioned, both the flat lands near the Columbia River and the rolling lands extending back several miles from it and in the Puget Sound region are used.

Many soil types are represented in the orchards of this district. Through the sections in Oregon brownish or reddish clay loams pre-

dominate, with subsoil heavier in texture but of the same material, which has been derived from the basalt rock with which it is underlain. In the lower valleys, notably that of the Willamette River, the humus content is rather high and the soil is loosened and darkened by it. This soil is deep and retentive of moisture. Through the red and brown soils of the rolling orchard sections the humus content is low, and the surface soil dries out rather quickly and is sticky when wet. When cultivated while too wet, it forms compact clods which are very hard when dry, but if this soil is tilled when in proper condition it works up into a light loam of excellent quality.

The surface soils in the plum-growing sections of southwestern Washington are, for the most part, sandy or gravelly loams, light brown, brown, and gray in color, underlain at a varying depth of about 3 feet and over with a deep stratum of very coarse gravel.

FIGURE 5.—A typical site of a prune orchard in the broken rolling section of northwestern Oregon.

This soil is easily tilled but is not retentive of moisture because of the excellent subdrainage. In the prune-producing sections farther back from the Columbia River the subsoils are finer in texture and more compact, and therefore more retentive of moisture. Soils built up by washings from the Columbia River and similar soils of the rolling section to the northeast of Vancouver Lake in Clark County, Wash., are deep, fertile, fairly retentive of moisture, and are prized for prune production (fig. 6).

In this district the rainfall is heavy during the fall, winter, and early spring, but drought prevails during the summer, the same as in most cultivated areas of the Pacific States. Almost no irrigation is practiced in this district, although the need for moisture is apparent during the late summer throughout most of the large orcharding areas, especially in rolling sections where the humus content is low and in places where the substratum of coarse gravel comes to within a few feet of the surface. There is some variation in the length of the dry season in different years. The rains sometimes start while the prune harvest is in progress and occasionally con-

tinue in the spring until the trees are in blossom. Injury to the crop results in either case.

Low temperatures have caused serious injury to the trees in northwestern Oregon and southwestern Washington, at least in the lowlands. The summers in this district are warm, but several degrees cooler than in the central California valleys and somewhat cooler than in the plum-growing centers of the valleys of California near the coast or of those of eastern Washington, eastern Oregon, and Idaho.

No plums are shipped fresh to the eastern markets from this district because of the moist atmosphere at harvesttime, with the resulting prevalence of brown rot. Although the major portion of the crop is dried, large quantities of fruit are canned fresh. The canned

FIGURE 6.—A comparatively old orchard of the Italian Prune in Clark County, Wash., near Vancouver. Trees planted 20 by 20 feet. The orchard has been well fertilized and tilled and produces well.

plum is an excellent product and is gaining in popularity. The total output of prunes is cured artificially, owing to the moist fall weather, which makes open-air curing impracticable.

The planting of plums has been confined largely to the Italian Prune variety, although a number of orchards of the Agen (or the Petite prune, as it is commonly called in the Northwestern States) are found. The proportion of the Agen prune is greater in Oregon than in Washington, especially in Douglas County. There are a few orchards of Sugar, Imperial Epineuse, and Standard prunes, but the output of these varieties is not important at present.

EASTERN OREGON, EASTERN WASHINGTON, AND IDAHO

The planting of commercial orchards of plums in the district embracing eastern Oregon, eastern Washington, and Idaho has been

confined almost entirely to the irrigated valleys, with important centers of production near Walla Walla, Wash.; the Milton-Freewater section of Walla Walla County, Wash.; in Umatilla County, Oreg.; the Yakima Valley in Yakima County, Wash.; and the Weiser-Emmett-Boise section in southwestern Idaho. Prunes are grown commercially, but not very extensively, in northern Wasco County, Oreg., near The Dalles, in eastern Whitman and southeastern Spokane Counties, Wash., and the bordering portion of Idaho, known as the Palouse region. There is no water available for irrigation in the last two sections, but orchards are maintained by dry-farming methods. Since the early nineties, when the major portion of the oldest plum orchards of this district were established, the growth of the industry has been slow until within the last 20 years, when extensive plantings were made. The Walla Walla, Milton-Freewater, and Yakima sections are centers where extensive new plantings were made during and following the World War. The increase is less marked in the fruit-growing portions of Idaho. But little planting has been done in any of these sections during very recent years, and now over 95 percent of the trees are of bearing age.

The soil in which fruit is grown in this district is, for the most part, a fertile, friable, easily tilled sandy loam of varying depth and organic content. It is everywhere sufficiently deep for good tree growth, and in some places, notably in the Yakima Valley, it is exceedingly deep. The surface soils are open and well drained, and the subsoils in most places are composed of stratified materials and are well drained also.

The sections from which plums are shipped from this district are semiarid to arid in nature. The summers are somewhat shorter than in the plum-growing sections of western Washington, western Oregon, and California, and the days are hotter than in western Oregon and western Washington, with the daily range of temperature greater. The rainfall is light, nearly all of it occurring from September to April. The total precipitation is considerably less than in the other districts described, except in the Palouse region. The fruit reaches good size and, owing to dry weather which usually prevails at harvesttime, may be successfully shipped to distant markets.

In the Palouse region, where the prevailing summer temperatures are low, the rainfall light, and only moderate cultivation is given, the fruit is usually below the sizes sent to the market fresh. A portion of the fruit from this region is shipped fresh when the prices for fresh fruit are high or the fruit for the season is above the average in size.

As in the sections farther west, the Italian Prune is by far the most widely used variety and the best for general planting. A considerable number of orchards of Pond, Tragedy, California Blue (Vacaville), Standard, and a few other varieties are found. The greatest acreage of varieties other than the Italian Prune is found in the Yakima and Walla Walla sections. In the Yakima district Japanese varieties or Japanese-American hybrids are grown to some extent, and the acreage devoted to them is increasing. Until recent years these varieties were grown in an experimental way only. Santa Rosa, Climax, and Burbank are the most popular of these

varieties. In southern Idaho the Italian Prune is grown practically to the exclusion of others.

The harvest of the Italian Prune for fresh shipment in this district starts about August 10 in the section near The Dalles, Oreg., and is followed in a week or so by that from the main irrigated centers.

In case of an unsatisfactory market for fresh fruit or if the fruit is small in size, a part of the crop is dried. All fruit for drying is processed by artificial means, the work often being done in central desiccating plants rather than in the small individual orchard driers.

CHOICE OF LOCALITY AND SITE FOR A PLUM ORCHARD

The plum is adapted to a wide range of soil and climatic conditions and is found in all sections where fruits are grown in the Pacific States. Prevailing temperatures in fruit-growing sections of this region are for the most part suited to commercial plum culture, though the rainfall is sparse during the summer, irrigation being necessary in some localities After the establishment of means of transportation through rural districts to central markets and the providing of means for irrigation, some points which require consideration are the selection of the proper soil type, the contour suitable for orcharding, and the locality where temperatures are congenial to the development of the variety the orchardist wishes to plant. Varieties grown for early fresh-fruit shipment are usually not types which sell well in the market with later maturing varieties and therefore should be planted where natural conditions favor their early ripening. Also, varieties grown for their dried product must be planted in places having a long growing season. Where fruit is for fresh shipment, not only the size of fruit must be considered but also the possibility of loss from brown rot. The climate must be sufficiently free from moisture at harvesttime to insure the fruit arriving in market without loss from decay in transit. The choice of a location and site for an orchard is then largely dependent upon the particular market in which the grower wishes to sell his product.

SOILS

Plums are not particularly sensitive as to soil, provided it is reasonably deep and fertile. They are found growing on a great number of soil types. The Japanese or American-Japanese hybrids, which make up a large acreage of plums grown for fresh-fruit shipment in California, will succeed on a soil more shallow and somewhat thinner than varieties of the *Prunus domestica* group, especially those which are grown for prune making. For the latter, only deep, fertile, well-drained land should be used, the heavier clay loams being preferable to the sandy loams. Soils which are underlain near the surface with hardpan should be avoided for plum culture.

Plum plantings for the most part have been made on soils derived from volcanic materials which have been laid down by sedimentation through the irrigated sections of Idaho, Washington, and Oregon; on the residual reddish clay loams and dark valley soils which have been filled in by washings from this type in western Washington and western Oregon; while in California, where the culture of this

XUM

fruit has been greatly diversified, many different soils are used. However, for the production of prunes, plantings here are confined almost entirely to the deep, dark, heavy loams such as are preferred by pear growers and which have been washed into the valleys from the surrounding hills. All varieties of plums for fresh-fruit shipment are grown in the valleys as well as on more upland soil, while those grown for their dried fruit are seldom planted on the more shallow uplands, where early shipping plums do well and have been extensively planted. For plums for fresh shipment, the more shallow, upland soils are not used except under irrigation or unless the soil type is such that it is very retentive of moisture, since a liberal supply of soil moisture is essential to the development of the large sizes demanded by the market for early plums. Notable among nonirrigated, rolling lands where plums for fresh shipment are grown is the rolling, hilly country lying in the immediate vicinity of Vacaville, Calif. Here the friable sandy loam, which is residual in origin, is well drained and open and warms quickly in the spring, and the subsoil and underlying sandstone, from which the soil has come through disintegration, is retentive of moisture, making natural conditions highly suited to the early ripening of fruit. In this region the summers are hot and dry, but the soil moisture is sufficient to bring a moderate crop of fruit to a desirable marketable size. Under these conditions the crop ripens several days earlier than in the immediately adjoining lower valley, where the deep fertile soil is more compact and slower in warming up in the spring. On the thinner soils of the hills, however, the tree growth is less than in the valley, and the crops are not so heavy as in the deeper soil.

Placer County, Calif., is situated on the western slope of the Sierra Nevada foothills, where the soil as a rule is not deep and is low in organic matter, but is open, friable, well drained, and under good cultural methods retentive of moisture. It is derived by the weathering of granite bedrock and is a sandy, gravelly loam, varying considerably in depth. Outcroppings of granite occur occasionally through the orchards, while good soil to the depth of 6 feet or more is commonly found. While plum growing is extensive in each of the localities just described, varieties for prune making have been planted very sparingly.

In the deep fertile alluvial soils in the Sacramento Valley plums for both fresh shipment and drying for prunes are grown side by side with equal success. Here the climatic factor is the one which influences the planter most in his choice of crops. In the interior valleys, where the climatic and marketing conditions are suitable, both plums and prunes are widely grown. On soils of the same general nature in the valleys near the coast climatic conditions cause a later harvest of plums for fresh shipment, and as a result they are but sparingly planted. Here prune production is the most extensive phase of fruit culture.

The principal soils used for plums in western Washington and western Oregon are the deep, enduring types, of both residual and sedimentary origin. In these soils the organic content is low except in the river bottoms, and when dry the soil is hard and difficult to cultivate. In a few smaller centers the soils are shallow, inclined to be heavy, and not conducive to a large tree growth or regular pro-

duction of good crops. In the eastern part of these States and in Idaho, orchards are found mostly in the deep sandy loams of sedimentary origin where the settling of volcanic material has been an important factor in the formation of the surface soil, as in the Yakima Valley of Washington. These grayish mellow soils are easily tilled, very fertile, and fairly retentive of moisture when well cultivated. Where they are of sufficient depth they are suited to plum and prune production, as both good size and a development that insures a good dried product are obtained.

Strata of hard, compact material or hardpan are often found within a foot or two of the surface in some types of sedimentary soils. The grayish open surface soil in such places is usually fertile if an excess of alkali is not present, but the greatest care and judgment should be used in selecting a site in such soils. In localities where a hard stratum of subsoil appears there is danger of selecting a site where the soil is of so little depth that it will become waterlogged by the settling of the moisture into the low places in the hardpan. Or one may find a soil which does not provide sufficient depth for normal root growth for plum trees. When planted on fertile shallow soils underlain with hardpan, trees often grow well for a few years and produce fairly well while young, but an unprofitable crop of fruit or the loss of trees often follows by the time full production should have been reached.

Soils rich in nitrogen may cause a thrifty growth, but those well balanced in available plant food are necessary for the regular and continued production of large sizes of well-developed fruit. While the size of the fruit for fresh shipment can be regulated to a considerable extent by the manipulation of irrigation water, fertile soils are necessary also for the proper growth and development of fruit. Excessive irrigation often causes poor tree and fruit development, and planting on poor soil results in a crop of small fruit which will prove unprofitable, since within the variety prunes are classified almost entirely as to size when placed on the market.

CLIMATIC CONDITIONS

The plum will thrive where winters are cold and will withstand hot summers, drought, and heavy rainfall as well as or perhaps better than other common deciduous fruits. Frequent and sometimes heavy losses are sustained in some localities, however, from injury to the blossoms by late spring frosts. Some varieties of the Japanese group in common cultivation blossom early in the spring, often several days or weeks before the last frost occurs, while the varieties of the domestica group, usually blooming considerably later, are seldom injured by frost. Practically all sections of the Pacific States where plums are grown commercially are visited occasionally by late frosts, although small areas of somewhat elevated rolling lands are considered to be free from any considerable loss from them. While the plum tree will withstand a heavy rainfall, rainy and foggy weather during blossoming time hinders pollination, and rains during harvest favor the growth of fungi, causing the fruit to decay and, therefore, seriously hindering both fresh-fruit shipments and prune making. For both long-distance shipment of fresh fruit and

XUM

for drying, which are the principal objects of plum growing in the Pacific States, the long, dry, hot summers which prevail are well suited.

In western Oregon and western Washington fall rains and high humidity at harvesttime make it necessary to dry fruit artificially. Dry fall weather usually permits open-air drying in California, although serious damage to the drying crop has resulted from rain.

Summer rainfall is exceedingly light throughout the fruit-growing sections of the Pacific Coast States, but the differences in temperature between the fruit-growing sections of these States is sufficient to cause wide differences in the practices followed in orchard management. For the most profitable production of early plums of Japanese and American-Japanese hybrid varieties, the fruit should be shipped before the later ripening varieties of the domestica group, which in the earliest plum-ripening sections of California is midsummer. This is possible only where the spring and summer are warm, as the later ripening varieties mature under such conditions before the earlier ripening ones in cooler regions. For this reason the cultivation of early-ripening plums has been largely confined to the hot interior valleys of California.

The mean spring and summer temperatures of a plum section largely determine the type of plum growing carried on there. For example, fruit for fresh shipment is largely grown in the hot interior valleys, as compared with the cooler Santa Clara, Sonoma, and Napa Valleys in California, where fruit for drying into prunes is principally produced. In the cooler valleys of California the Agen prune is the principal one grown, while in the Northwestern States, where still lower mean temperatures prevail, the Italian Prune, planted only sparingly in California, is grown almost exclusively. However, in a few places in the warmer sections of these States the Agen and other varieties of the domestica group are cultivated to a considerable extent. Temperatures of the principal plum-growing sections are given in table 1, compiled from the records of the Weather Bureau.[2]

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*

[Data for representative plum and prune producing sections of each district, from the summaries of climatological data for the United States by sections for the different stations, as follows: *A*, Section 14, central and southern California, p. 22–24; *B*, section 16, northwestern California, p. 16–17; *C*, section 15, northeastern California, p. 36–37; *D*, section 17, western Oregon, p. 18–19; *E*, section 19, western Washington, p. 9; *F*, section 20, eastern Washington, p. 10; *G*, section 22, southern Idaho, p. 5]

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
		°F.	°F.	°F.	°F.	°F.	°F.	°F.
San Jose (*A*)	Maximum	63.8	69.9	72.3	76.9	80.9	79.9	79.3
	Minimum	43.7	44.4	45.8	48.7	52.0	51.2	50.0
	Mean	53.7	56.7	60.7	65.0	66.9	66.7	64.7
Hollister (*A*)	Maximum	64.4	69.2	71.5	77.2	81.2	79.8	79.1
	Minimum	40.6	41.5	43.8	46.8	48.7	49.2	47.5
	Mean	54.5	58.2	62.3	65.9	67.2	66.7	65.6

[2] U. S. Department of Agriculture, Weather Bureau, Climatological Division. Summaries of climatological data sections. U. S. Dept. Agr., Weather Bur. Bul. W, vol. 1, 1912.
——— Summary of the climatological data for the United States, by sections. U. S. Dept. Agr., Weather Bur. Reprint [Revision of Bul. W] Sect. 14–17, 19–20. [1912–18.]

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*—Continued

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES—Continued

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
		°F.	°F.	°F.	°F.	°F.	°F.	°F.
Napa (*B*)	Maximum	63.0	68.8	72.9	79.0	81.2	80.5	80.8
	Minimum	42.1	43.8	47.1	50.5	52.8	52.1	50.1
	Mean	52.6	56.8	60.8	65.4	67.6	67.0	66.0
Healdsburg (*B*)	Maximum	67.1	73.5	77.2	83.8	89.4	87.7	85.6
	Minimum	40.5	43.3	46.2	49.4	50.8	49.3	47.7
	Mean	52.1	56.9	59.9	65.9	68.5	66.5	65.7

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

Tulare (*C*)	Maximum	69.0	77.5	82.4	91.7	99.6	97.2	88.8
	Minimum	40.8	44.5	49.9	56.1	60.2	58.9	52.7
	Mean	55.9	62.6	68.2	77.4	83.0	80.1	71.9
Stockton (*C*)	Maximum	60.9	67.9	73.5	82.7	88.5	86.5	81.8
	Minimum	43.2	46.6	50.0	55.6	57.0	56.5	54.8
	Mean	54.5	58.9	64.1	69.9	72.6	72.5	69.0
Chico (*C*)	Maximum	66.3	73.0	79.9	89.3	98.9	97.4	88.7
	Minimum	41.2	44.8	49.0	55.0	60.2	58.3	53.5
	Mean	55.6	61.6	68.4	77.1	83.9	81.5	74.6
Auburn (*C*)	Maximum	62.5	69.0	74.7	85.1	91.7	91.8	83.5
	Minimum	42.0	44.7	50.1	55.0	61.1	60.3	54.4
	Mean	51.7	56.5	62.7	70.8	76.8	75.9	71.0
Vacaville (*C*)	Maximum	65.9	71.5	78.5	84.1	93.5	92.1	86.4
	Minimum	42.7	45.4	48.6	51.7	55.8	55.6	52.5
	Mean	53.9	58.8	64.2	71.0	75.5	74.5	70.8

WESTERN OREGON AND WESTERN WASHINGTON

Roseburg, Oreg. (*D*)	Maximum	57.0	62.1	68.0	72.7	81.0	81.2	74.1
	Minimum	38.1	40.1	44.9	48.9	52.6	52.3	47.9
	Mean	47.6	51.4	56.5	60.8	66.9	66.7	61.1
Salem, Oreg. (*D*)	Maximum	55.1	60.9	66.3	72.0	79.6	80.1	72.0
	Minimum	37.9	41.0	45.5	49.7	53.3	53.1	48.7
	Mean	46.2	50.8	55.9	60.9	66.4	66.4	60.3
Vancouver, Wash. (*E*)	Maximum	55.9	62.5	66.8	72.7	79.7	79.5	72.8
	Minimum	37.1	39.7	45.3	49.7	53.2	52.3	47.9
	Mean	45.7	51.6	57.5	62.2	66.9	66.2	60.9

EASTERN WASHINGTON, EASTERN OREGON, AND IDAHO

Walla Walla, Wash. (*F*)	Maximum	54.2	63.5	71.3	77.8	88.2	86.7	75.5
	Minimum	36.8	42.6	48.6	53.7	60.8	60.2	52.3
	Mean	45.5	53.0	59.9	65.8	74.5	73.5	63.9
Moxie, near Yakima, Wash. (*F*)	Maximum	56.5	66.5	74.0	80.9	88.9	87.4	77.3
	Minimum	28.5	34.3	42.0	48.0	53.1	51.1	42.4
	Mean	42.6	50.4	58.2	64.6	71.3	69.5	59.9
Boise, Idaho (*G*)	Mean	44.2	50.1	57.6	66.0	72.8	71.8	61.9

PALOUSE REGION, WASHINGTON

Colfax, Wash. (*F*)	Maximum	50.8	60.0	67.9	73.9	82.8	82.8	72.2
	Minimum	30.0	35.1	40.5	44.6	47.4	46.5	40.4
	Mean	40.4	47.6	54.2	59.3	65.1	64.9	56.3

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*—Continued

SUMMARY OF AVERAGES BY DISTRICTS

	Mar.	Apr.	May	June	July	Aug.	Sept.
	° F.	° F.	° F.	° F.	° F.	° F.	° F.
Maximum:							
San Francisco Bay and central California coast counties	64.6	70.3	73.5	79.2	83.2	81.9	81.2
Interior valleys of central California	64.9	71.8	77.8	86.6	94.4	93.0	85.8
Western Oregon and western Washington	55.7	61.8	67.0	72.5	80.1	80.3	73.0
Yakima and Walla Walla, Wash	53.5	65.0	72.6	79.6	88.5	87.0	76.4
Minimum:							
San Francisco Bay and central California coast counties	41.7	43.2	45.7	48.8	51.1	50.5	48.8
Interior valleys of central California	42.0	45.2	49.5	54.6	58.8	57.9	53.6
Western Oregon and western Washington	37.7	40.2	45.2	47.1	53.0	52.6	48.2
Yakima and Walla Walla, Wash	32.6	38.4	45.3	50.8	57.4	55.6	47.3
Mean:							
San Francisco Bay and central California coast counties	53.2	57.1	60.9	60.5	67.5	66.7	65.5
Interior valleys of central California	54.3	59.6	65.5	73.2	78.3	76.9	71.6
Western Oregon and western Washington	46.5	51.2	56.6	61.3	66.7	66.4	60.4
Yakima and Walla Walla, Wash., and Boise, Idaho	43.4	51.2	58.6	65.5	72.5	71.2	61.9

SITE AND LOCATION

In choosing a site and location for plum growing careful consideration should be given to spring frosts, soil drainage, transportation facilities, and also to irrigation in sections where it is necessary.

If spring frosts are common, rolling or sloping land should be chosen, avoiding the low, flat plains, depressions, and troughs of ravines through which the cold air, like water, flows to lower levels.

FIGURE 7.—Sites on a slope where soil and air drainage are better for orchards than in the lower portion of the valley in the distance, Emmett, Idaho.

Even differences of a few feet in elevation often prove of great importance in this respect (fig. 7).

The growth of plum trees on fertile soil washed down through ravines encourages the orchardist to continue plum planting there, but in such locations the planting of fruits which blossom later in the spring would usually result in less loss from frost and no doubt

prove more profitable. Orchards occupying the rolling areas bordering the larger fruit-growing valleys, while more difficult to cultivate, are decidedly more nearly free from frost injury to the blossoms than those on the low flat valleys or the high flat tablelands.

Where the soil near lakes of considerable size or ocean bays is suited to cultivation, only little, if any, loss from spring frosts need be feared. In the consideration of sites such places are preferable because the water will temper the hot days of summer as well as protect from the cold in spring. The effect of such a body of water is well illustrated near the border of Lake Vancouver, not far from the city of Vancouver, Wash., where prune production is an important industry and where it is claimed that severe injury to the crop by frosts is unknown. The opposite result in regard to frost naturally obtains along smaller rivers, as here the heavy cold air settles in and follows the course of the water.

FIGURE 8.—Prune trees, dead as a result of poor drainage—the fate of trees on low, heavy soil.

Soils which are low, heavy, and in danger of becoming waterlogged during wet seasons or in which surplus water from irrigation collects should also be avoided. While the plum is not so sensitive to an excess of soil water as some fruits, small crops and weak trees and often loss of trees follow planting in such places (fig. 8). Only well-drained soils should be selected.

The unquestionable advantage of facilities for irrigation in the regions where irrigation is practiced prove the need of choosing lands where a system is already established or where a water supply sufficient for the type of soil under consideration can be made available. Both prunes and plums are sold largely by their size, and as the soil moisture determines to a great extent the sizes of the fruit the water supply should not be overlooked.

The condition of country roads and the proximity of packing houses and shipping stations need also to be taken into account. While these are not so important where the fruit is to be dried, good smooth roads, preferably free from dust and with packing and shipping facilities close by, are decided advantages to the shipper of fresh plums who must send his product to distant markets.

XUM

VARIETIES

The ease with which new strains and varieties may be created by artificial crossing or by the selection of chance seedlings and the patience and intelligence exercised by many western plum growers in testing new types have led to the development of a large and ever-increasing number of varieties. Many of these varieties have been taken into almost every locality where orcharding is not entirely prohibited by natural conditions, and the requirements of varieties with respect to soil, weather peculiarities, and cultural conditions, both natural and artificial, have been determined perhaps more closely than for any other of our cultivated fruits.

Many of the commercial varieties of plums widely planted in the Pacific States were originated or first introduced into cultivation there, and in most instances in central California. Many new varieties of promise are now being introduced to the trade.

In establishing an orchard for the production of plums for the fresh-fruit market, it is the practice to plant a number of varieties which ripen in succession, so that the fruit pickers may go from one variety to another without interruption, thus avoiding the necessity of procuring additional help to harvest the varying number that ripen at the same time. Where there is a period of a few days between the ripening of varieties in the succession, or if a variety fails to fruit, considerable confusion and perhaps financial loss results from the disorganization of the picking, packing, and hauling crews. This emphasizes the importance of selecting varieties for their regular bearing habits as well as for quality and appearance of fruit and those so suited to the peculiar soil and climatic conditions that they fit into the successive ripening scheme.

Many varieties are partially or entirely self-sterile. When such varieties are planted, other sorts which will pollinize them must also be planted nearby. At the same time these pollinizers must possess desirable qualities for commercial planting and likewise fit into the list for successive ripening. With the great number of plum varieties, each with its peculiarities as to growth, production, quality of fruit, and the broad demands of the grower and the market, the choice for planting becomes one of greatest importance to growers. For prune making the conditions to be met are not so numerous as in the production of fruit for fresh shipment. The selection of a variety adapted to the natural local conditions, including soil and climate, is the principal problem. Shortage of labor and the loss of a little time in harvesting, processing, or delivering to local or distant markets cause no such loss or concern to the grower who dries his fruit as to the one who must harvest, pack, and deliver his fruit to the consumer within a relatively short time or else withstand a severe or perhaps total loss of his fruit by spoiling or having his product offered on a market when the price is unsatisfactory.

The expense of picking and packing the fruit, the purchase of shipping containers, and the cost of icing and transportation to the distant market is relatively considerably higher for the fresh fruit than for the dried product. Owing to these expenses the hazards in the production of fresh fruit are considered by many to be greater

than for prunes, although the high market price for fresh fruit makes its culture desirable if natural conditions are favorable to the development of large fruit of good quality. A large number of varieties are under cultivation for the production of both fresh and dried fruit, although the diversity required for the profitable growing of fresh shipping plums has led to the planting of a much greater number of varieties for this purpose than for prune production.

The dates of blooming as well as of ripening of a variety may vary from a few days to 3 or 4 weeks from year to year with the different varieties, depending on climatic conditions. Slight fluctuations sometimes occur in the relative ripening dates of varieties, although within a given orchard these differences are small. At different elevations and under other varying conditions both blossoming and ripening dates of a variety may differ considerably even in adjoining orchards. The conditions that prevail in low, wet, heavy lands and at high elevations tend to cause late blossoming and ripening of the fruit, while those that characterize the well-drained soils of low, rolling land, especially those of southern and eastern exposure, favor relatively early blossoming and ripening.

Considering the principal plum sections in California, in which are grown more or less extensively nearly all varieties of plums produced commercially in the Pacific States except the Italian Prune, harvesting starts during the latter part of May in the lower San Joaquin Valley and about a week later in the foothill section near Vacaville, in Solano County. In the Vaca Valley, which borders these foothills, the earliest harvests are about 1 week later and almost simultaneous with the foothill section of Placer County and a few days in advance of the main portion of the Sacramento and San Joaquin Valleys.

The principal variety grown for fresh shipment in the other States included in this discussion—Oregon, Washington, and Idaho—is the Italian Prune. Other varieties grown commercially in these States include Tragedy and Pond, with less important plantings of California Blue, Standard, and a few others. The ripening dates of these varieties in the Pacific Northwest are 3 or 4 weeks later than in the plum-producing sections of California. Only a few varieties are favored for planting in the Pacific Coast States at the present time, although large fruit shipments are made from many other varieties that were planted in recent years.

A few important qualities of the most prominent commercial varieties growing on the Pacific coast at the present time are here described to guide the orchardist in his choice for future planting. These varieties represent three groups or classes of plums: (1) The Japanese sorts, those derived from the oriental form known to botanists as *Prunus salicina*, including many varieties grown for their fresh fruit; (2) those derived from the European form (*P. domestica*), which includes the so-called European, domestica, purple, or blue plums and to which belong the varieties grown for prunes as well as many for shipping fresh; (3) hybrid sorts originated by crossing Japanese with native plums, grown for use in the fresh state.

XUM

VARIETIES OF PLUMS AND PRUNES IN THE PACIFIC STATES

VARIETIES OF THE PRUNUS SALICINA (TRIFLORA) GROUP AND ITS DERIVATIVES OR HYBRIDS

Beauty.—This is the earliest ripening of the commercially grown varieties and is therefore a favorite in sections where fruit is produced for the early market. Cross-pollination is not essential. The tree is thrifty and inclined to bear well and regularly; thinning the fruit is found necessary almost every year. The fruit is medium in size, often with considerable variation on the same tree. It is very attractive and carries to the market fairly well. This is the most popular early ripening variety at present.

Burbank.—This is one of the principal varieties of the Japanese group grown on the Pacific coast. Its harvest comes after the Climax and Maynard and just before the Santa Rosa. The fruit is medium in size and quality and carries to market exceedingly well. The Burbank is a regular and prolific bearer, and unless thinned the fruit is often undersized. The blossoms are self-sterile, but appear with those of many other varieties which, if near by, are usually sufficient to pollinize it. The ripening season is rather long. The tree is thrifty, spreading in habit of growth, and suited to a wide range of climatic conditions. This variety is planted for its regular and heavy crop of fruit, but it ripens in the middle of the plum-shipping season, and low prices are sometimes received for it.

Climax.—Fruit large and attractive, but ripens rapidly, is rather soft when ripe, and therefore requires considerable care in harvesting and must be hurried to market. The blossoms are self-fertile, and regular crops of fruit are therefore expected.

Duarte.—Fruit very large, of good shipping quality, and has attractive dark-red flesh. This is the earliest to ripen of the so-called "blood" plums, but one of the latest of the Japanese type of varieties grown for fresh-fruit shipment. Its blossoms are self-sterile, but appear late, and good crops are expected where the trees are planted near other varieties of the same group.

Formosa.—While among the earliest ripening varieties, its fruit is very large. It is one of the most attractive of commercial plums, of excellent eating quality, and carries to distant markets exceedingly well. The blossoms open early in the spring and therefore are in danger of being injured by frosts and are self-sterile. The tree is thrifty and grows to a large size, but is inclined to come into bearing late. As a result, many orchards of it have been top-grafted to other varieties and its planting has been nearly discontinued. Good crops have been harvested where trees are growing near the Wickson, the Santa Rosa, and some other varieties of the Japanese type and when there is an abundance of bees. The yield of this variety is usually the best when it is top-grafted on old trees.

Gaviota.—Fruit very large, attractive, of good eating quality, fair in texture, and keeps and ships exceedingly well. The blossoms appear rather late, and the fruit ripens among the latest of the varieties of this type and a little after midseason for fresh-plum shipments. On account of its firm flesh the fruit may be harvested over a long season and if picked when well ripened will still reach the market in good condition. The trees are vigorous, prolific, and inclined to be regular in bearing if the blossoms are pollinized. Its blossoms are self-sterile, and the trees should therefore be planted near other varieties of the same group which blossom at the same time. This variety is still popular for planting.

Kelsey.—Fruit large, of good eating quality, attractive when well colored, keeps and ships well, has a rather long ripening season, and is one of the latest of the more extensively grown Japanese varieties. The fruit colors well in sections where cool summer breezes prevail and in foothill sections, but poorly in the hot floor of the interior valleys of California where fruit for fresh shipment is grown extensively. Its blossoms are self-sterile, but it usually bears well when planted with closely related varieties. In sections where the fruit colors well this variety is now popular for planting.

Santa Rosa.—This variety is harvested somewhat before midseason, and the ripening season is longer than for many varieties of Japanese plums. The fruit is large and very attractive, purplish crimson in color, having dark-red flesh of fine eating quality, and carries well to market. It blooms early, and the blossoms are sometimes injured by frost. It is benefited by cross-pollination and on account of late frosts and faulty pollination is inclined to be

irregular in bearing. The Wickson and Beauty varieties, blossoming about the same time as the Santa Rosa, have been recommended for planting near it for pollinizers. The tree is a vigorous, compact, upright grower and should be pruned to induce a moderate new growth and an open framework. Severe cutting back of the tops causes a long, erect growth of new wood which forms a compact top, thus heavily shading the branches and spurs of the old wood. This is now a favorite among Japanese plums for planting.

Satsuma.—Fruit of good size, dull red in color, and purplish red flesh. It is of good flavor, high in dessert quality, and favored for culinary purposes but not for shipping fresh, although a small acreage is grown for this purpose. The tree is vigorous, but inclined to bear light crops until it reaches several years of age.

Wickson.—Fruit very large, attractive, good in flavor and dessert quality, and carries to market well. It is one of the earliest varieties to blossom in the spring, and late frosts often shorten the crop. It requires cross-pollination. As it blossoms with but few other varieties, light crops sometimes result from lack of other pollen. It is planted more extensively along the Pacific coast, probably, than any other variety of the Japanese group.

VARIETIES OF THE PRUNUS DOMESTICA GROUP

Agen (*French prune or Petite prune*).—The fruit of this variety is perhaps the smallest of any of those used for prunes. It is dull reddish purple in color, and very rich and sweet in flavor, and has a rather tough skin. As the sugar content is high, it dries quickly and easily. The tree is thrifty, a moderately vigorous grower, and regular and prolific in its bearing habits. It blossoms in midseason for the prune varieties and ripens its fruit late. The fruit clings to the tree until after drying starts, which insures against injuries during harvest, thereby shortening the period which would otherwise be required for it on the drying trays. The planting of this variety exceeds by many times the combined area of all other varieties grown for prunes in California, and it is of commercial importance in western Oregon and western Washington. Its blossoms are self-fertile, and it may therefore be planted in solid blocks, although interplanting with the Sugar and Imperial Epineuse varieties has been recommended as a benefit to fruit setting. It requires a deep fertile soil for the production of good crops of large fruit. Adverse local conditions or overheavy crops result in small fruit. An abundant supply of small fruit, with prices on a size basis, is the chief hindrance to a satisfactory market price for this variety.

California Blue.—Called Vacaville in some sections. Fruit ripens in midseason, is medium to large in size, round, bluish in color, of only fair dessert quality and flavor. Its ripening period is rather short. The tree is very prolific, but it bears only in alternate years, at least in some localities. Its blossoms are self-fertile. The tree is inclined to branch but little, is spreading and open in habit, and produces fruit on wood of all ages, making the harvest easy. As yet its culture has been confined mostly to a few sections in central California near which it was originated, although it is giving encouraging results in central Washington orchards. It is not favored for planting at present.

Clyman.—Ripens earliest among the domestica group of plums on the Pacific coast and follows closely the earliest of the Japanese group. It is dark blue in color, of medium size, only fair in eating quality, and carries only fairly well in shipment. The blossoms are self-sterile, open early, and the trees should therefore be interplanted with other early blossoming varieties. The Tragedy variety has been suggested as a pollinizer. Clyman is not a dependable producer in most sections, probably on account of lack of pollination and injury by frost. The tree is a vigorous grower and favored as a stock for top grafting, but is no longer planted for fruit production.

Diamond.—Fruit large, handsome, rather sour, and second rate in eating quality, but its tartness has made it a favorite during late years in eastern markets. It is firm in texture and carries well to distant markets. Its fruit ripens a little after midseason and is the first purple plum of commercial importance to ripen after Tragedy. The wood of this variety makes probably the poorest union with the peach stock of any of our commonly cultivated plum varieties.

Giant.—Fruit medium to large in size, attractive in appearance, but lacking in flavor and juiciness. Owing to its rather dry flesh it carries to market exceedingly well. Its blossoming season is late, and the fruit ripens among the

XUM

late varieties commonly grown for their fresh fruit. The fruit is about midway in size between that of its parents, the Agen and Pond. Like the former the tree is vigorous, its blossoms are self-fertile, and it fruits heavily from year to year. It resembles the Pond in that the fruit is somewhat lacking in flavor and juiciness and is rather coarse. It is not popular for planting at present.

Grand Duke.—A plum which has been widely tested in plum-growing centers of the Pacific States and is extensively planted in California. Its fruit is large, firm, not very juicy, has a high sugar content, keeps and ships well, but is second rate in dessert quality. The blossoms appear late and require cross-pollination. The fruit ripens late and the ripening season extends over a comparatively long period.

Imperial Epineuse.—Fruit large when compared with that of other varieties grown for shipping fresh and larger when dried than that of other varieties commonly used for prune making. It is dark red, juicy, of good quality and appearance, and excellent in eating quality. Owing to the high prices paid for the dried fruit, the larger portion of the crop of this variety is made into prunes. The tree is vigorous, but inclined to be a shy bearer in most localities, this being due, probably, to the lack of cross-pollination. The Agen and Sugar varieties have been recommended for interplanting with the Imperial Epineuse as pollinizers. The tree requires a deep, fertile soil for satisfactory growth. This requirement, together with its irregular cropping tendencies, has prevented it from being extensively planted in some plum centers. It is at present grown to a considerable extent in many places, and in the Sonoma Valley is one of the most favored varieties.

Italian Prune.—Fruit medium to large, dark purple in color, of a pleasing tart flavor, and firm in texture, making it first class both for fresh shipment and for drying. It is also used largely for canning. It is grown extensively for these purposes in Oregon, Washington, and Idaho, where it is by far the most important variety under cultivation and one which is still the most extensively planted. The blossoms are self-fertile, and therefore it may be planted in large blocks without other varieties. It is adapted to a wide range of temperature, but requires a deep, fertile soil.

Jefferson.—Fruit similar to Golden Drop and used for canning, as is that variety; it is one of the most popular varieties for that purpose. Although a fruit of good eating quality and flavor it is not favored for fresh shipment on account of its color. Owing to the very restricted demand for plums for canning, the demand for trees of this variety for planting has nearly ceased.

President.—Fruit large in size, very dark purple in color, of fair eating quality and texture, ripens among the latest of the purple domestica plums, and carries to the market well. The tree is thrifty and inclined to bear regular and heavy crops. It is recommended for planting by those who wish to grow late-ripening plums for the fresh market.

Pond.—Called "Hungarian prune" on the Pacific coast. Its fruit is large for the commercially cultivated varieties of this group, very attractive, and purplish red in color. Its flesh is firm and lacking in juiciness, making it well suited for shipping. In eating quality it is only second or third rate. There is a tendency for the fruit to form doubles, one side often being imperfect in shape. Such fruits are not favored in the markets and are difficult to pack. Its blossoming season is intermediate with other plums and its fruit-ripening season is late. The branches make a slender upright growth and are inclined to send out too few fruiting twigs and branches. The tree should be pruned to induce a moderate wood growth and branching. In the interior valleys of California, where the summers are hot, the tree is lacking in vigor. There is often a poor wood and leaf growth and considerable sunburning of wood and fruit. In States farther north, where the summer temperatures are lower, the tree is thrifty and productive, with decidedly less injury from sunburning.

Reine Claude.—Considered one of the best varieties for canning, but on account of the small size of the fruit and the light demand for plums for canning, its planting has been almost discontinued.

Sergeant (*Robe de Sergeant*).—Fruit somewhat below the medium size of varieties of this group grown for their fresh fruit. When dried it is about medium size among the prunes. Its dark-purple color, becoming almost black when the fruit is ripe, and its rich pleasant subacid flavor make it well suited for prunes. The tree is thrifty but often fails to bear satisfactory crops, especially in the cooler sections. It is considered profitable only on deep fertile soil, as elsewhere the fruit is too small. This variety has been grown to a

considerable extent in California, although new plantings of it are rare both there and in the States farther north.

Sugar.—Fruit medium in size when compared with other varieties grown for fresh shipment, although considerably larger than its parent, the Agen. It is dark purplish red in color, juicy, and has a rather tender skin. It is sweet, but otherwise second rate in dessert quality. The blossoms appear late, making them comparatively free from danger of frost injury. Being also self-fertile, good crops are usually insured. The trees of this variety are inclined to be prolific. If the fruit is not thinned, small sizes usually result, and an excessive crop is often followed by a light one or a failure the following year. The tree is open and spreading and the wood very brittle and inclined to become stunted where little pruning is done. Good soil and cultural conditions are required for a satisfactory tree growth. When the market price for plums is low, the fruit is dried into prunes, although considered only second class for this purpose. While less popular at present than in past years, it is still found in practically all centers of plum production in the Pacific States.

Tragedy.—One of the earliest and best as to eating quality of the domestica plums that are grown for fresh shipment and for profitable returns. It is grown in most sections of central California from which fresh plums are shipped, and to some extent in central Washington. Its fruit is medium in size for a domestica, attractive in appearance, and ships well. The blossoms are self-sterile, and poor crops often result from this cause. The Clyman has been recommended as a pollinizer.

Yellow Egg.—Fruit large, only fair in eating quality, and rather soft when ripe, making it inferior in this respect for fresh shipment. Its golden yellow color makes it suitable for canning, but not for selling fresh. For canning it is one of the most favored varieties, but the decreased demand for plums for canning has resulted in the top-grafting of some orchards of this to other varieties. The trees are vigorous and inclined to bear regular and heavy crops.

POLLINATION

Among the foremost of the considerations to be given to the planting of plum orchards is that of pollination. This is more especially true with varieties for fresh-fruit shipment, for many common varieties grown for this purpose are entirely sterile with their own pollen, or the crop may be greatly increased by cross-pollination. To the lack of pollination many light crops or entire failure may be attributed. In some instances the planting of a variety has been discontinued on account of poor crops from this cause.

The most practical means for providing cross-pollination in commercial orchards is to interplant varieties which may be fitted into the scheme of a ripening succession to extend the fruit harvest. In the interplanting of varieties it may be convenient to plant the succession so as to accommodate fruit-picking crews, but this should be done in every case to favor pollination. Only a few rows of a variety known to be entirely or to a large degree self-sterile should be planted together. Solid blocks of these varieties should never be planted, as with self-sterile varieties. For convenience in fruit harvesting, from two to four rows of a variety are usually planted together.

In the selection of a pollinizer, provided more than one variety will cross readily with the one to be pollinized, a variety which blossoms with it, having a long blossoming period and regular in blooming habits, should be chosen rather than one which tends to blossom in alternate years.

As a group the Japanese varieties and those derived from them are considered to require cross-pollination or to be greatly benefited by it with the exception of the Climax, which is self-fertile. Among the domestica varieties (the only other group represented in com-

mercial plum planting in the Pacific States), the Tragedy is self-sterile, as are also the Imperial Epineuse and other less important varieties. Several of them, including two important varieties for prune production—the Agen and Italian Prune—are self-fertile.

While varietal tendencies regarding pollination are very decided, the percentage of blossoms to set fruit, irrespective of weather conditions, varies with the age and thrift of the tree. Where top-grafted on older trees, especially if the stock and scion are somewhat uncongenial and produce an imperfect union, a heavier set of fruit sometimes results than from normal trees. Heavy crops under these conditions have been noted in the case of the Formosa variety. This is a self-sterile sort and notorious for coming into bearing late. Eight-year-old grafts of the Formosa in old apricot trees adjoining Santa Rosa trees have been observed to bear excellent crops, while 8-year-old Formosa trees started in a nursery and planted the same distance from the Santa Rosa trees as were those produced by top-working bore practically no fruit.

FIGURE 9.—Bee stands in a plum orchard. Cross-pollination in plum and prune orchards by bees has been proved of so much importance that many of the growers in California place stands in their orchards, at least during the blossoming period.

The presence of bees in the plum orchard at blossoming time has been demonstrated to be almost an economic necessity (fig. 9). Poor crops or perhaps failures may be expected of self-sterile varieties where no bees are present, and even with self-fertile varieties the presence of bees has caused a decided increase in the crop.

Cold, foggy, or rainy weather at blossoming time is very detrimental to the setting of fruit. A careful selection of varieties must be made for planting in places where such weather is common during the spring, and commercial plantings should be confined to varieties that have proved themselves suitable to the local conditions.

STOCKS USED IN PROPAGATING PLUM TREES

Only a small portion of the plum trees for commercial planting are propagated in the home nursery, professional nurserymen being

depended on to supply trees with stocks suited to the orchard conditions. In his selection of stocks the nurseryman is guided by the demand of orchardists for trees propagated on one stock or another and by his own interest in producing cheaply propagated trees which make a rapid growth.

For propagating plum trees the myrobalan plum and the peach are by far the most important, although the almond is used in some localities, at least in California. An occasional orchard may also be found where the Marianna plum and the apricot are used for stocks. Each of the first three stocks mentioned is suited to different soil conditions, and the myrobalan plum and the peach are suited to the soils generally chosen for plum planting. The myrobalan plum is preferred for deep, heavy fertile soils, especially if the rainfall is heavy or the orchard is under irrigation. It is not a rampant grower, but is a vigorous, long-lived, hardy, and deep-rooted tree, the roots withstanding a higher soil-moisture content than other kinds of roots. The myrobalan plum, however, prefers a deep, fertile, heavy, well-drained loam and is therefore at home in soils favored for prune production and is in most general use in that industry. It is also the one most commonly used for planting in the deep, fertile bottom lands, where plums are grown for the fresh-fruit market and for canning.

The peach root, while less resistant to excessive soil moisture than the myrobalan plum, will thrive better than the latter or other stocks mentioned in poor, shallow, or light soils, because its roots do not go so deeply into the earth, but make a vigorous spreading growth. A good moisture content and a soil of good tilth are, of course, required for the best root growth of the peach. It starts growth early in the spring, grows rapidly, succeeds in a wide range of soils, and is generally considered the most satisfactory stock for early ripening plum varieties, at least in the shallower soils, where these varieties are extensively grown. It is used to a considerable extent for varieties for prune making where the soil is not sufficiently deep or the moisture content is below that required for the best development of the myrobalan roots.

The almond, one of the stocks used in California, is a thrifty long-lived tree, growing best in deep fertile well-drained soil and is the most drought resistant of the stocks commonly used. It does not withstand excessive soil moisture as well as the peach or the myrobalan plum, but succeeds in places where it is too dry for those stocks. The plum tree is generally considered to grow less rapidly on the almond root than on the others commonly used and is propagated less extensively on it than on the others. The almond is used to some extent as a stock for prunes in deep fertile soils not under irrigation. Large old prune trees which have excellent records of fruit production are found growing on this stock.

The Marianna plum is employed as a stock for plums in California, but it is more sensitive to drought and to excessive soil moisture than the other stocks, suckers badly, and is generally little used. It grows quickly and well from cuttings, which insures cheap and uniform stocks.

In the Northwestern States the myrobalan plum has been used almost exclusively as a stock since plum growing became an impor-

tant industry there; but in California, where fruit growing is a more diversified industry and the growing of plums for fresh shipment is a comparatively new enterprise and the demand for different fruits has fluctuated considerably, the stock which is at present considered best for planting under a given condition is not the one found in the orchard in a great number of instances. Much superficial testing of different stocks has been in progress, and the changing popularity of varieties has caused many orchards to be top-grafted to other fruits or varieties, although the tree which then becomes the stock is not in all cases the one on which the new variety should be grown.

TOP WORKING

The principal reasons for top working in the commercial orchard are the changing demands of the market in regard to the variety

FIGURE 10.—Old apricot trees top-grafted to plums. The trees on the left have just been grafted; the scions will start into growth as the trees renew their activities in the spring. On the trees at the right the grafting was done 5 years before. Vacaville, Calif.

and quality of fruit and the desire to bring the trees quickly into production (fig. 10). As there has been an ever-changing demand in plum varieties, especially those for fresh-fruit shipment, much top working of trees has been done in sections of central California where the growing of plums for fresh shipment is an important industry. In these sections top grafting has been practiced since commercial plum growing was first established, and it is still a common procedure. It has proved to be a satisfactory method for changing the production of an orchard from one variety of plums to another, for the replacing of certain other fruits with plums, and for testing new varieties by bringing them quickly into bearing (fig. 11). Only a few years are required for the new top to come to commercial production where conditions for fruit growing are good and where varieties inclined to be prolific are used. A crop of one to two crates of plums per tree has been harvested the second season after top grafting, thus causing an interruption of only 1 year without

a marketable crop in changing trees from one variety to another. This, however, is a more rapid change than would usually be expected. The top grafting of peach trees to plums was practiced to a large extent in this region a few years ago, owing to the greater popularity of the plum than the peach.

The operation of top grafting is easily performed, and success may be expected if the trees selected are vigorous. The work of top grafting is usually done in winter and spring after the pruning has been finished. In performing this work only strong, well-spaced, and well-shaped branches should be selected. These should be carefully sawed off at the desired height and the scions inserted by either the cleft or bark-grafting method. As large wounds heal slowly, making the entrance of wood-rot fungi probable, small branches are preferred to large ones. If a limb 2½ or 3 inches in diameter or a little larger must be selected, at least three scions should be inserted, while for the smaller branches two are sufficient.

FIGURE 11.—An orchard of top-grafted plum trees at Vacaville, Calif. These trees were originally the Kelsey plum. They were top-grafted 8 years before to the Beauty plum.

Instead of top working by grafting, budding into small branches which grow from cut-back limbs is sometimes practiced for changing the tree from one fruit to another.

In top grafting, the unfortunate use of scions of varieties which do not form strong unions with the stock has resulted in the loss or poor growth of many trees. While the varieties of Japanese plums most commonly grown are inclined to be congenial with the peach stock, a number of varieties of the domestica group are not (fig. 12). The Diamond, Grand Duke, and California Blue varieties when grafted on peach make perhaps the poorest unions among the varieties of this group in the region under observation, although the tree may continue to bear profitable crops over a considerable term of years after grafting. When a variety is top grafted to an uncongenial stock it will often appear undernourished, owing to the inability of the plant food to pass readily into the tissue below the

FIGURE 12.—Poor graft unions resulting from top-worked old peach trees with the Grand Duke plum. The plum grafts are 12 years old. Note the enlargement of the lower portions of the grafts and injury from sunburn below. Vacaville, Calif.

FIGURE 13.—A poor union of the Grand Duke plum on a peach tree, resulting in poor growth, sunburning of the limbs, and subsequent decay and weakening of the branches. Such branches are easily broken by winds.

graft union. The poor growth of foliage resulting from this condition causes poor protection from the sun; the old branches of the stock sunburn easily and are therefore more easily broken by the wind than where good unions are formed with the scion (figs. 13 and 14).

The plum on the apricot or almond sometimes gives unsatisfactory results in top grafting, while good unions are expected in grafting one variety of domestica plum with another, and in grafting Japanese varieties on domestica varieties. Trees known to form poor unions with the variety the orchardist wishes to grow are sometimes top-grafted with a variety known to unite well with both, and the next year these grafts are worked to the variety chosen for fruit production (figs. 15 and 16). "Double working," as this practice is commonly termed, may be used in some instances to decided advantage if the trees to be top grafted are large and well-shaped.

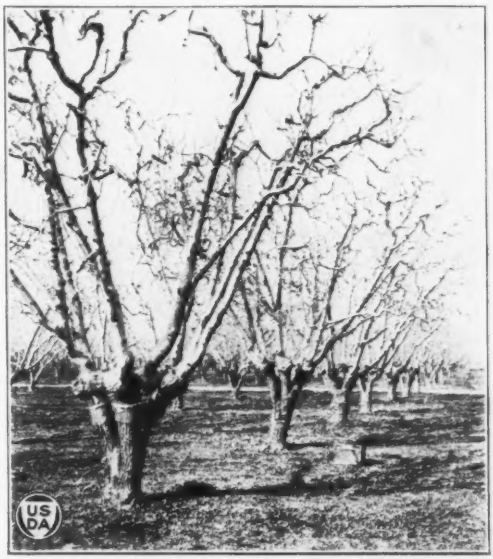

FIGURE 14.—A row of peach trees which were top-worked to the Diamond plum. The enlargements at the points of union between the peach and plum wood indicate a lack of congeniality, although a fairly strong growth has been made by the plum top. The plum tops are about 20 years old.

To secure an open growth for a variety naturally compact and upright growing, the variety is top-grafted on one that is naturally open and spreading. This is done after the spreading tree is 2 or 3 years old and has its framework branches established (fig. 17).

That there is some obscure factor involved in the congeniality of stock and scion is suggested in figures 18 and 19, which show the Agen (*French prune*) top-worked on almond trees. In one case faulty unions have developed; in the other, congeniality appears to exist. Other similar instances are matters of observation.

Prior to actual trial there is apparently no means of determining what plum or prune varieties will show congeniality with particular stocks. For example, the Agen has given excellent results when top-worked on apricot, though the plum wood at the point of union may grow somewhat larger than the apricot wood. The Agen propagated in the nursery on almond stocks sometimes makes a good growth, and the trees are long lived and vigorous. On the other hand, in the case of the Imperial Epineuse plum, after

growing for nearly 25 years the limbs top-grafted on a myrobalan plum tree began to indicate weakness at the point of union.

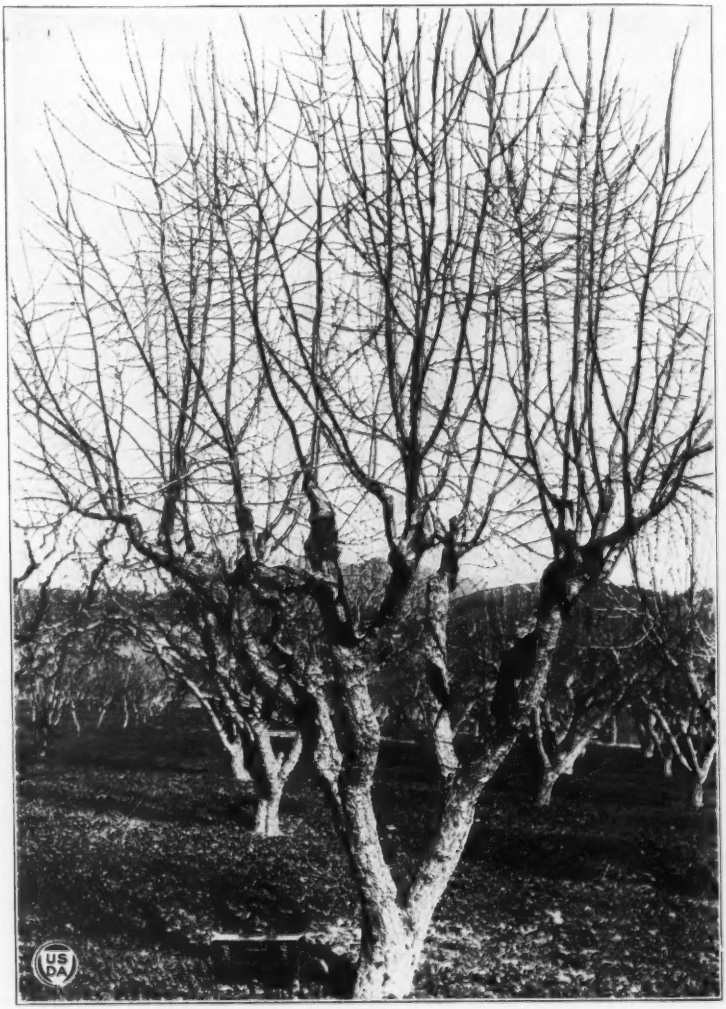

FIGURE 15.—Top of a seedling plum tree (in the foreground) 2 years after being double-worked on apricot. A short section of Pond (*Hungarian prune*) is between the base of the plum limbs and the apricot. The tree therefore shows an apricot base top-worked to the prune, which in turn was grafted over to a seedling variety of plum.

It does not necessarily follow that a variety propagated in the nursery on a particular stock and grown successfully in the orchard

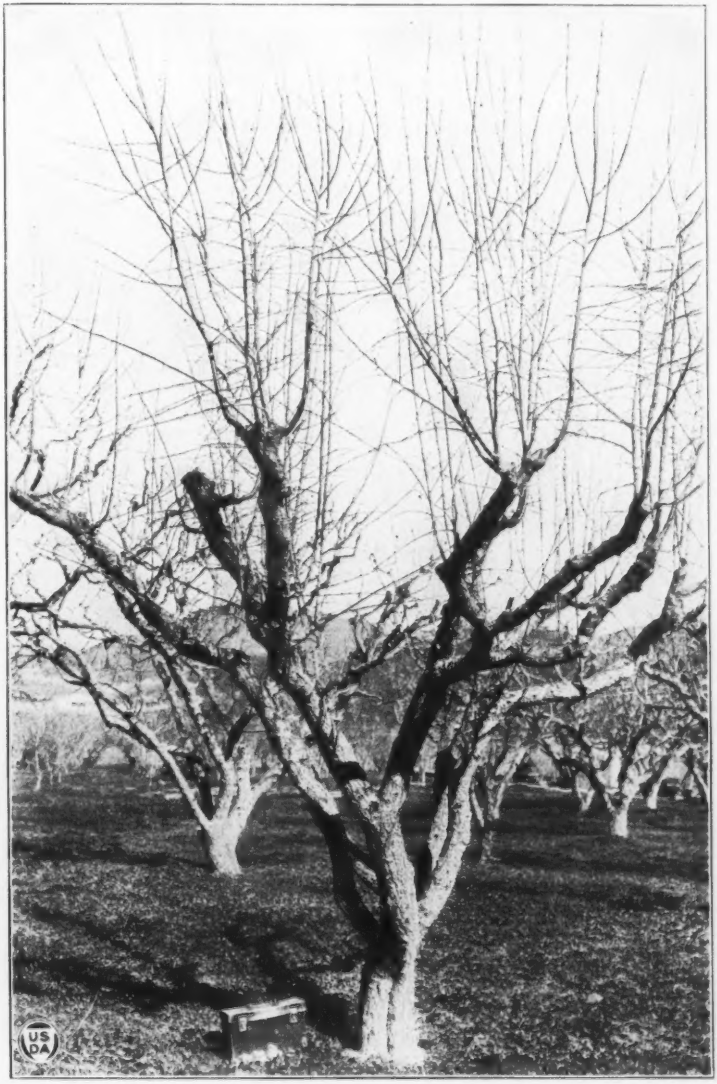

FIGURE 16.—Scions of the seedling plum referred to in figure 15 grafted directly into apricot limbs. The growth of the plum branches, where double-worked with sections of Pond (*Hungarian prune*) wood between the plum and the apricot, is appreciably more vigorous than in the present case. This obviously suggests, although it does not prove, that double-working in this combination is advantageous.

will give the same successful results if top-worked into a mature tree of the same species as the seedling nursery stock.

The work of top grafting is not difficult or complicated. With moderate skill and a little practice one may expect a large percentage of his scions to grow. As the new top grows, all rough portions of the stubs in which the scions were placed should be carefully removed

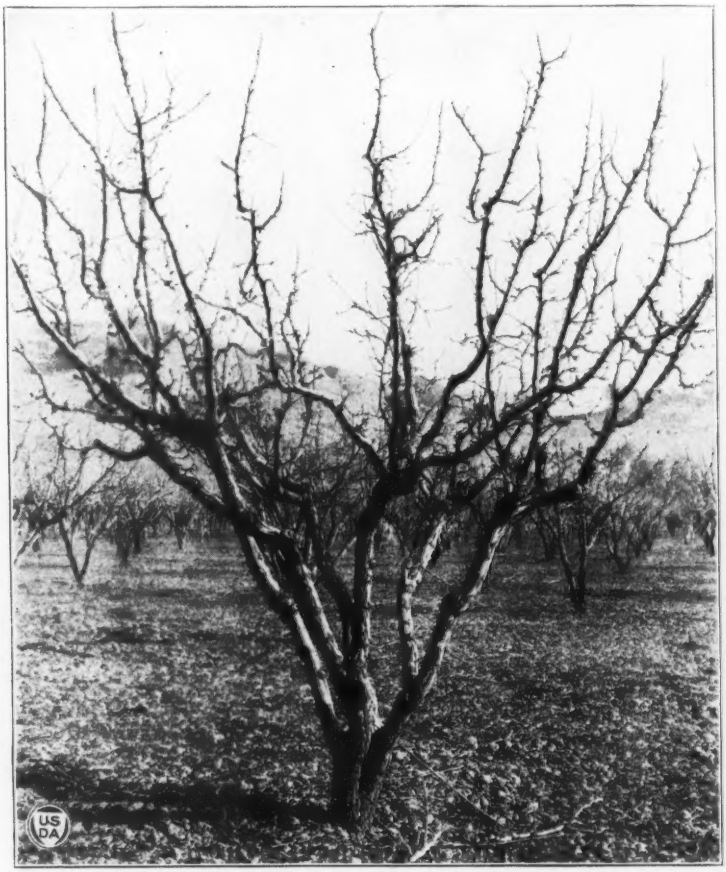

FIGURE 17.—The Formosa plum, an upright-growing variety, top-grafted on a 5-year-old peach tree to make an open top. Vacaville, Calif.

with a saw and chisel to insure the healing of the stump as quickly as possible. Where tree tops are removed for grafting, the stumps not needed should be carefully removed and the others protected from the sun with whitewash, especially if the trees are young and their branches are not protected by thick bark. The growth of young branches to furnish shade should be encouraged also. Carelessness in grafting and neglect of the old stumps and branches

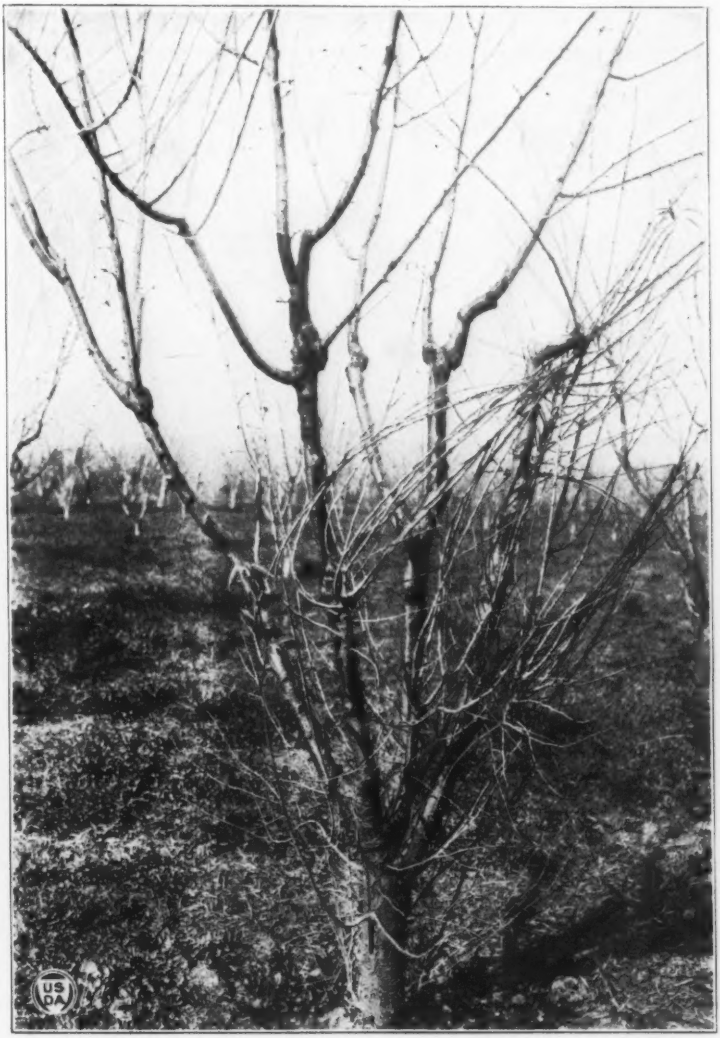

FIGURE 18.—An Agen (*French prune*) tree top-grafted on an almond stock. The union between the almond and the prune wood is poor, and the growth of the prune top is unsatisfactory. Sprouts have been allowed to grow on the almond portion of the tree for the purpose of nourishing the roots. In some instances this practice has resulted in a marked improvement in the general condition of the tree. It would appear that in this case almond roots can maintain the Agen prune top, but that the food material elaborated by the latter does not adequately maintain the almond roots.

in succeeding years, both through failure to remove dead stumps of branches or portions of them which the new scion cannot over-

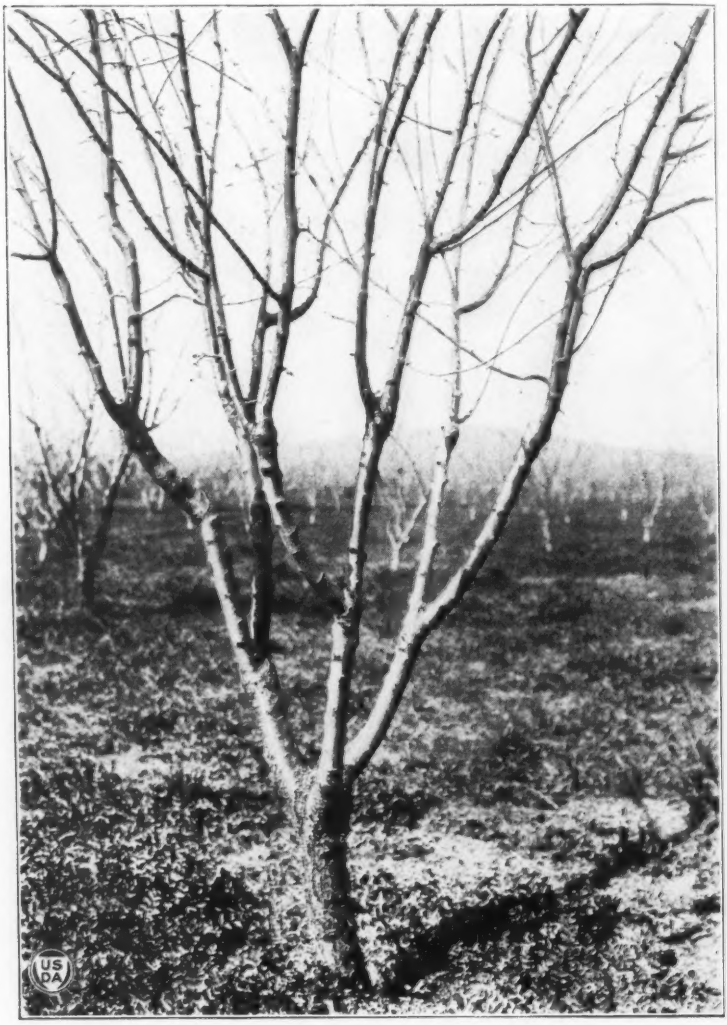

FIGURE 19.—An almond tree the main limbs of which, like the one shown in figure 20, have been top-grafted to the Agen (*French prune*). This tree stands next in the row to the one shown in figure 20, but the congeniality between the almond and the prune appears to be satisfactory, and the tree is thrifty. A varietal strain or other obscure factor may explain the difference in the congeniality in these two instances.

grow, has often resulted in sunscald, followed by the entrance of wood-decaying organisms and the ultimate loss of the tree. Such

losses usually follow several years of unsatisfactory crops of fruit, and are by far the most severe on top-grafted trees where stock and scion are somewhat lacking in affinity (fig. 20). Wood-decaying organisms, entering through grafting wounds or sunburn following grafting, are a very common cause of loss of top-grafted trees and necessitate the removal of a large number of trees annually. Often the removal of the entire orchard is necessary, owing to the poor stand of thrifty trees remaining after the removal of dead or unprofitable ones.

FIGURE 20.—Sunscald and decay in a peach stock which resulted from top-grafting with an uncongenial variety of plum, followed by neglect in caring for the stumps of branches removed in top-working.

DISTANCE FOR PLANTING

From 18 to 24 feet has been the range commonly used for spacing plum trees in the orchard, 20 feet each way being the most common distance. Where soils are fertile but the trees of the varieties planted are naturally small or upright in habit of growth or conditions are not generally suited to the production of large trees, the shorter distances are usually preferred. They are also sometimes preferred where a method of pruning is used to maintain low compact heads, provided water for irrigation is available, so that the trees cannot rob each other of their needed moisture supply. For trees naturally thrifty and planted for a permanent orchard, 20 feet each way is generally considered the best distance. In fertile, well-watered soils 26 to 28 feet each way is believed best for naturally large growing prune trees.

Planting too close has been the cause of many light fruit crops, of alternate bearing of trees, and of the generally poor production which is common in some districts. If close planting is practiced where the soil is of only average depth and quality, or where irrigation is lacking, or where culture is in part neglected, only irregular crops and slow, weak growth may be expected after the trees are a few years old and the roots have occupied all the land. Where ideal cultural conditions prevail, with a pruning program suited to the

variety and conditions, fair yields may be expected even with close planting (fig. 21).

NURSERY TREES FOR PLANTING

One-year-old trees of average size are considered most suitable for orchard planting. All trees should be propagated on the kind of stock best adapted to the land to be planted, and all should be free from injurious insects and plant diseases. Provided the interstate and intercounty quarantine regulations have been properly carried

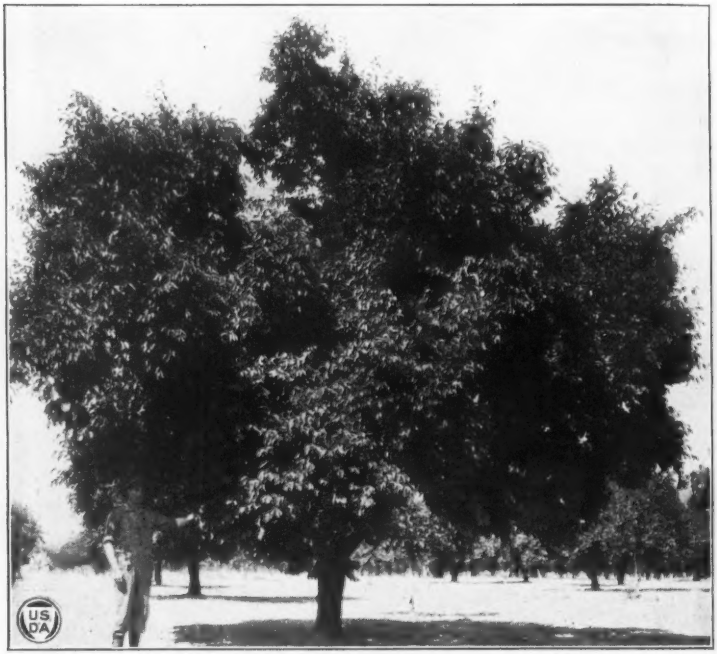

FIGURE 21.—A 30-year-old Italian Prune tree which is prolific and bears regularly while standing where it is not crowded. Under similar soil conditions in a nearby orchard, but with the trees planted 18 by 18 feet, the growth of the trees is poor and the production irregular. Douglas County, Oreg.

out, there will be but little risk in regard to insects and diseases when buying a nursery tree, and the purchaser should make sure that all provisions of the law pertaining to the sale of nursery trees in his locality are strictly adhered to. Nursery trees with a well-developed system of thrifty roots and of average size rather than very small or extra large should be chosen.

TIME FOR PLANTING

Like other deciduous fruits, plum trees should be planted sufficiently late in the fall so that new wood will not start growth until

the following spring, or they may be planted in the spring while the soil is still cool and before the time for wood growth to start. The trees should never be planted until the soil has been well prepared and is sufficiently moist to prevent the roots from becoming dry. In California, western Oregon, and western Washington, where the winter temperatures are mild, plantings may be made at any time during the winter and even until after March 1, with little fear of injury to the trees.

Loss of trees from carelessness is a common occurrence in newly planted orchards. Where planting is for any reason delayed after the trees are received from the nursery they should be heeled in carefully in a light, moist soil until ready for planting. Care must be taken to protect the trees from the sun and drying winds while handling, for neglect at any time from the time they are dug in the nursery until they are planted in the orchard may result in loss or delay in growth.

ORCHARD CULTURE

The cultural operations as practiced in most commercial plum-growing centers of the Pacific States are a combination of cultivation, irrigation, and the growing of cover crops. Where water for irrigation is available these operations are closely related, and the performance of one is often dependent on the other. In nonirrigated sections cover crops must be handled at the convenience of cultivation. As most of the annual rainfall in the plum-growing centers of these States is confined to the fall, winter, and spring seasons, occurring mostly while the trees are dormant, and as the summers are hot and dry, cultivation to destroy vegetation and thereby prevent the loss of moisture through it is important if irrigation is not practiced. Under these conditions it is the custom to plow to a moderate depth as early in the spring as the soil becomes sufficiently dry to work well, following the plow with some tillage implement designed to smooth and loosen the surface.

Too much care cannot be given to the choice of the time for this spring plowing. If the soil is worked while too wet, so that it is compacted, as in the case where the surface of the furrow is left shining when it is turned by the plow, the soil will dry out hard and remain so for some time. In this condition disintegration in this compact soil is delayed, with the result that the development of the food supply for coming years will be retarded. Adobe soils, which in some localities are planted to plums, must be plowed when wet, but such soils crumble or slake to some extent upon drying and may then be worked to the desired texture. On the other hand, if the soil is too dry when first plowed, the operation will be difficult and usually poorly done. The soil will turn up cloddy, and only an ineffective soil mulch will be formed, permitting further drying of the subsoil. When the moist soil crumbles into small particles upon leaving the plow, covering well all vegetation, subsequent tillage is more effective and conditions for the fruitfulness of the trees much better than if the land is plowed when either too wet or too dry. Deep spring plowing which will prune the new root growth should be avoided, especially after the fruit has set. During the remainder of the summer, shallow-going tillage implements should be used at intervals to destroy vegetation and so conserve soil moisture.

XUM

It is claimed by both growers and buyers that plums from soils that are nonirrigated but well-cultivated are better in eating quality, carry better when shipped fresh, and dry into heavier prunes than those grown on land where frequent and abundant irrigations are given.

The number of cultivations required under the local climatic and soil conditions must be determined by the orchardist, who must fulfill but not exceed the demands of economy in his orchard-cultivation expenses.

To eradicate noxious weeds, of which the grasses and the morning-glory are the most troublesome, frequent plowing, rather than the use of shallow-going implements for stirring the surface soil, is necessary.

Where cover crops are grown in nonirrigated sections care must be taken that the plowing is done when the soil is in the proper condition. Spring plowing is sometimes delayed to permit a heavier growth of the cover crop, but with doubtful benefit in nonirrigated sections, since in such sections soil moisture is the principal limiting factor to successful plum production. Cover crops are highly desirable if their growth is made during the late summer and fall, but not if they are grown in the spring at the expense of moisture which should be retained for the trees. If the plowing is done so late that the cover crop does not decay promptly a free passage for air will be provided and the subsoil immediately below will dry out rapidly.

Systems of tillage and cover cropping differ considerably in irrigated and nonirrigated sections. Under irrigation the soil moisture taken by the cover crops may be replenished and cover crops managed more at the pleasure of the orchardist. The soil may be prepared at any time for seeding these crops and moisture for their germination and growth provided by irrigation. If, owing to miscalculation in the spring, the soil becomes too dry to plow well, water may be applied, although it is considered better to plow when the soil first reaches the proper condition than to allow it to become dry. It is a common practice after this plowing to go over the orchard once or twice with a disk or drag harrow, giving no further cultivation except the necessary furrowing for irrigation until the time for seeding a fall cover crop. Where water is scarce or expensive, irrigation is delayed as long as possible in the spring, and unless the orchard has a permanent cover crop it is the usual custom to water not more than once, if at all, after the fruit is harvested. This is in early summer in the sections of California from which fruit is shipped fresh. This often allows the soil to become too dry for the best development of the trees. It also causes a shortening of the growing season, on account of lack of moisture in the fall, and consequently a low food reserve for tree development and fruit production. To conserve the moisture after the winter rains and again after irrigating thorough surface cultivation to eradicate weeds cannot but prove profitable.

Where there is a hard stratum within reach of the subsoiler with open fertile soil below, subsoiling and blasting to break up this stratum are sometimes practiced with good results. Such soils are rarely suited to growing late-maturing varieties for either shipping fresh or drying for prunes.

IRRIGATION

On account of the semiarid and arid conditions prevailing in nearly all plum-growing sections of the Pacific States, irrigation is looked upon as essential in many districts and highly desirable in all. A large percentage of the area devoted to this crop is now under irrigation. Where thorough tillage is given, however, especially in the cooler sections and where the soil is naturally retentive of moisture, many growers believe that the returns from their orchards would not be sufficiently increased to justify the expense of installing irrigation systems. In a few places either insufficient water or tillable land areas too small to be suited for fruit growing make the installation of irrigation systems impracticable.

The method most commonly followed in applying water in irrigated orchards is either flooding, accompanied by checks, or admitting the water to small open ditches or furrows running parallel with the tree rows.

For irrigation where the water passes down slowly or where heavy applications are desired, as in the deep fertile soils used for prunes, flooding is more common than watering in furrows.

Ditches for irrigation are made by furrowing with a plow, and from one to a half dozen furrows are made in the space between rows. If moisture moves out freely from the furrows or water is scarce, a furrow on either side of the row is, in some cases, all that is used, but where water is plentiful and the soil such that the water percolates through it slowly more furrows are needed. On hillside plantings a furrow on the uppermost side of each row is sometimes considered sufficient. As the highest concentration of available plant food is near the surface and the soil there is best suited to root growth and activity in absorbing nutrients, the furrows for irrigation should be so close that moisture from one furrow will meet that from the next immediately below the soil mulch. In most soils water goes rapidly downward with but little lateral movement. This movement quickly carries much of the irrigation water below the feeding roots and leaves broad dry areas between the furrows if but one or two furrows are made between tree rows. A considerable portion of the soil is thus utilized but poorly, if at all, by the roots during the dry summer when the tree should be storing food at its maximum capacity. With bearing trees which have a broad spreading root system, this results in a decided handicap to the tree and consequently affects the profits from the orchard. In making furrows for irrigation, shallow ones are best on shallow or compact soils where the lateral movement of water is slow; but in deep loamy open soils where the root systems are deep and there is a free lateral movement of water through the soil, deep furrows may serve as well and provide easier handling of the water.

The frequency with which irrigation should be made and the quantity of water to be applied depend much on local soil and climatic conditions, the variety of fruit grown, the cultural practices followed in the orchard, and the prevailing price of water. When the soil is light and well subdrained and water moves rapidly downward frequent light applications are considered better than fewer heavy ones. Soil inclined to be heavy needs water less frequently and in greater quantities. In sections where water is expensive and

FIGURE 22.—A portion of an Agen (*French prune*) orchard on deep fertile soil which was irrigated in former years but not the current season. The leaves are wilting and dropping prematurely and the trees otherwise suffering from lack of moisture.

the supply limited, only one application is given in the summer, usually a short time before harvest, if the plums are for the fresh market, so that the fruit may reach the largest size possible. Where

FIGURE 23.—A portion of the orchard shown in figure 22, which has received moderate irrigation the current season. The better condition of this part of the orchard as compared with the nonirrigated part is apparent.

there is an unlimited supply of water and the charges for it are low, it is often the practice to give frequent and sometimes heavy irrigation. But under this method the soil soon becomes compact, aeration of the subsoil is hindered, and naturally an unthrifty root system develops. Where the soil is deep, moderately well drained, and irrigated water is expensive, as is the case in by far the greater part of the plum-growing sections of these States, it is the usual practice to give moderate irrigations at as widely separated intervals as conditions will permit. Four or five waterings during the summer are considered by many to be necessary. Many orchards, however, are

FIGURE 24.—An Italian Prune tree in the nonirrigated rolling section near The Dalles, Oreg., where the summers are hot and dry. An excellent soil mulch is maintained in summer by frequent tillage. In this section the tree tops are thinned out and the branches shortened by annual pruning. The trees are vigorous and productive of excellent large fruit.

maintained in a thrifty condition during the long, dry summers with only two or three waterings, followed by cultivation (figs. 22 and 23) to destroy vegetation.

Irrigation should not be substituted for cultivation to obtain thrifty trees and profitable crops in orchard, but should be resorted to for the purpose of supplementing it in order to maintain the soil moisture at the point of greatest efficiency for tree and fruit development (fig. 24). Most plum orchards, especially those where late-maturing varieties such as are used for prunes are grown, are located on soils easily tilled and naturally retentive of moisture. For such no definite rule for applying water need be given. The orchardist must judge the needs of his trees by their apparent vigor.

It must be remembered, when considering irrigation, that drying of the soil causes severe injury to the feeding roots and that frequent moistening and drying is decidedly less beneficial to the tree than keeping the soil constantly in good condition, which can be accomplished best by moderate irrigations followed by surface cultivation to destroy vegetation and aid nitrification.

Where an accumulation of alkali endangers the thrift of the tree, irrigation water may be used to decided advantage in washing out and carrying away these soluble salts, provided the soil is of such texture and slope that a good head of water can be forced across the orchard and the excess carried off in drains. In this operation the alkali-laden waters must not be allowed to accumulate in low places in the field, thereby merely shifting rather than removing the trouble.

COVER CROPS

The use of cover crops has become common but by no means universal among plum growers of the Pacific States. The need for these crops in this region is generally recognized, as the soils for the most part are low in organic matter and available nitrates. Since the summer rainfall is light, the development of moisture-retaining qualities is highly desirable. Rank-growing leguminous plants, which will furnish a large quantity of organic matter as well as store nitrogen taken from the air, are always preferred and are the only ones in general use, although the wild vegetation made up of nonleguminous plants and weeds as well as leguminous plants is sometimes allowed to grow in the orchard.

Both perennial and annual plants are grown for cover crops. In the irrigated sections of eastern Washington, eastern Oregon, and Idaho perennial crops are planted almost to the exclusion of annuals, while with but few exceptions annual plants only are used in the sections of Oregon and Washington west of the Cascade Mountains and in California. Perennial cover crops are not used in orchards where the fruit is used for prune making, as here it interferes with the fruit harvest. Among perennial cover crops alfalfa is the one in general use, although red clover is still grown in a few orchards. Alfalfa has been adopted by the larger percentage of plum and prune growers in localities where perennial cover crops are grown.

Where the soils are very fine grained and lacking in humus they become very compact under irrigation and cultivation, and the movement of irrigation water into them is naturally very slow. It is believed the filtration of irrigation water through such soil is decidedly facilitated by the growing of a permanent crop of alfalfa. At the same time, the nitrogen and humus provided by it are much needed and are responsible for increased vigor and production of the trees.

Alfalfa is not always managed as a cover crop when grown in the orchard, but sometimes as an intercrop, although planted primarily for the benefit of the trees. As it is a deep-rooted vigorous plant, it requires a deep fertile soil, such as is commonly planted to late-ripening plums. It not only will not succeed well but will result in injury to the orchard if the soil is shallow. As alfalfa requires large quantities of water, provision should be made for irrigation

before the seed is sown, or at least the ground should be leveled and the main lines for irrigation established. Whether planted in newly set orchards or in older ones, a good seedbed should be prepared for the alfalfa. It is a common custom to seed the entire surface, although planting in the areas between the rows is sometimes practiced, especially if irrigation water is not plentiful.

When the alfalfa has made some growth, it is important that the period between irrigations should not be too long. The benefit from the loosening of the soil by the alfalfa roots for the free passage of water is not apparent for the first few months after planting, although both the crop and the trees are drawing heavily upon the moisture near the surface during this time.

Water for the alfalfa crop is usually applied in from two to five furrows between rows of trees, the number depending upon the soil type and the ability of the water to pass laterally through it. The applications must be at rather frequent intervals and most often when the alfalfa is making a rapid growth after a harvest. Less water is needed after the alfalfa has reached full growth in orchards where it is not harvested but grown as a cover crop only. To give the quantity of water required for the best growth of the alfalfa may easily result in poor crops of fruit and greatly shorten the life of the orchard. An excess of subsoil moisture in orchards where alfalfa is grown is indicated by small leaves and a lack of vigor in the growth of the wood of the current season and finally by the loss of a tree here and there. On shallow or thin soils the same indications may appear, and on such soils alfalfa should not be used.

Where the alfalfa is not harvested the heavy crop of vegetation for working into the soil supplies an abundance of humus, forms an excellent mulch to protect the surface soil from drying out quickly, and maintains a more equitable temperature for root growth in the surface soil than where frequent cuttings of hay are made or clean culture is practiced. The alfalfa does not require as much water when not harvested as when frequently cut, and where fewer irrigations are necessary there is a more uniform moisture content in the soil. It is often claimed that the water necessary for the plum orchard under clean cultivation equals that where alfalfa is grown but not harvested, while the tree growth and fruit production are decidedly greater. Under clean culture, water penetration is often slow, and proportionately more irrigation water is lost by evaporation. Where cut for hay, a harvest is usually made just as the fruit is ripening, to make fruit picking easier; and where it is allowed to remain on the land, the crop is broken down with a roller or disk or cut with a mower and then worked into the surface soil, so as to be out of the way of the harvesting crews.

Where alfalfa is grown as a permanent cover crop it is necessary occasionally in most places to plow under the old crop and seed a new one. This is due, in part at least, to the alfalfa being gradually crowded out by weeds and grass which grow from seed carried in by irrigation water.

Red clover, when planted for a permanent orchard cover crop, is managed in the same way as alfalfa. On account of its shallower root system the planting of it has been almost entirely replaced by alfalfa.

XUM

Perennial cover crops are rarely grown in plum and prune orchards in western Oregon, western Washington, and California, but annual ones are planted or the growth of weeds and other plants that develop without hand seeding is encouraged in most orchards. Vetch, melilotus, and horsebean are the most favored crops for planting in these sections. Oats, barley, or some other small grain is sometimes planted as a cover or soiling crop, either by itself or with vetch to support it in the spring and to prevent its being blown down or lodged by rain. Except for the purposes just mentioned, small grains and grasses are not recommended as cover crops in the plum section of the Pacific States if leguminous or other more suitable plants can be grown successfully. Bur-clover is among the most commonly grown plants adapted to a wide range of soils and well suited to the climatic conditions of the plum-growing regions of California. It is a vigorous grower, easy to manage, a very satisfactory cover crop, and may be plowed under during the spring like other annual cover crops. To perpetuate it without the expense of reseeding, occasional plants are allowed to remain undisturbed, or the tips are left uncovered when plowing. These blossom and ripen seed, which remains in the ground for growth the next fall.

Annual crops are sown late in the summer, sometimes immediately after the first fall rain, or, if rains are late, after an irrigation. To insure quick germination the seed is often sown on the surface and not worked into the soil. If covered, a portion of the seed may not germinate until the following spring, possibly too late for the plants to make a satisfactory growth before plowing. After seeding no further attention is given the cover crop, as the fall and winter rains are usually sufficient for a good plant growth. When the winter and early spring temperatures are moderate, a good growth is usually made by the cover crop; but if the growth has been slow, spring plowing is sometimes delayed for a few days after the soil has become sufficiently dry for plowing to permit the growth of the cover crop. This practice, however, is often attended with injurious results.

A poor growth of the cover crop is often noticed in old orchards where clean cultivation has been practiced for a number of years and in localities where the soil is lacking in available nitrogen. A number of places have been observed where the growth was exceedingly poor except in portions of the orchard where stable manure or commercial fertilizers had been applied. In those places a rank thrifty-growing crop was found.

INTERCROPS

Intercropping is often practiced in plum orchards on high-priced land. Among annual crops beans, corn, pumpkins, and garden crops are planted extensively, usually profitably, even where the soil is of only moderate depth, if water is plentiful and good soil management practiced. Where such crops are grown the results indicate that they are decidedly preferable to small grains and grasses. Aside from alfalfa, the perennial crops used for interplanting with plums include hops, walnuts, other deciduous fruits, and berries (figs. 25 and 26). Each of these crops is confined to a more or less restricted set of conditions, and all need fertile soils. Hops are sometimes planted at the same time as the prune trees, or if prunes are planted in the hop field,

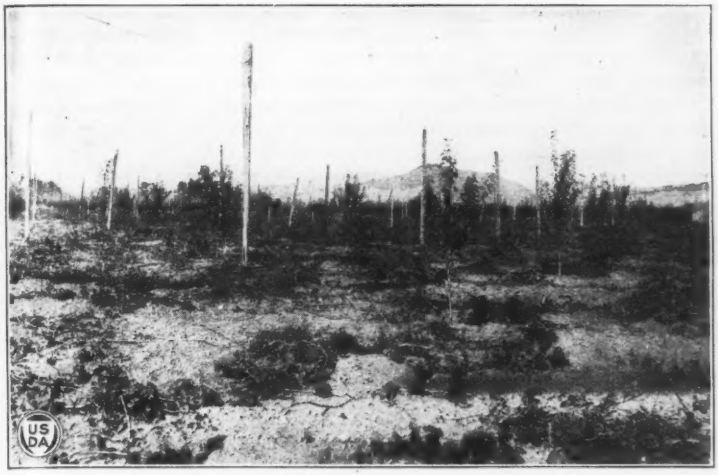

FIGURE 25.—A 2-year-old Agen (*French prune*) orchard interplanted with hops in California. The hop harvest had just been completed.

the hops are allowed to remain until the trees are a few years old. The time for removing them depends on the relative value of the two crops, but they should not be left longer than 4 or 5 years after the

FIGURE 26.—A young Agen (*French prune*) orchard with an intercrop of winter cauliflower. Santa Clara Valley.

prunes are planted. This practice is most common in some of the warm valleys of California, where a substitute for hops is sought. Where Persian walnuts are planted with plums it is usually the plan

to remove the plums when the walnuts have come into bearing. This plan is also followed with other deciduous fruits, but sometimes both crops are planted with a view to deciding which shall be the permanent orchard when both have come into bearing. The use of vegetables and berries as intercrops is usually discontinued when the plum trees approach full bearing.

PRUNING

At the time of setting in the orchard, the nursery tree, which is usually a whip, is cut back to a bud where the uppermost branch for forming the head is desired. This height varies greatly with different growers and with the variety and the purpose for which it is grown. With those grown for their fresh fruit, 2½ feet is about the height preferred for cutting back the young tree, particularly those which

FIGURE 27.—High-headed Italian Prune trees intercropped with potatoes. Clark County, Wash.

are most inclined to be upright in growth, such as most Japanese varieties. The same height, or even a lower head, is favored by growers of the Agen (*French prune*), especially in California. In States farther north, where the Italian Prune, a comparatively spreading tree, is the important variety, the nursery tree is cut back to a height of 3 to 3½ feet or even more for the formation of the tree head (fig. 27). The height at which the branches are to produced should be determined by the habits of the variety (whether spreading or upright), by the implements to be used in cultivation, and by the disposition to be made of the fruit. If the fruit is for fresh shipment, low branches make the harvest easier; but for growing prunes, where the fruit is shaken from the trees, the formation of the tree head may be somewhat higher without particular disadvantage except that the danger of injury by sunburn on the trunk is increased.

Three branches are usually desired for forming the lower framework of the tree, although some growers prefer four or five. These branches are selected from among those growing from the upper part

of the trunk, care being taken to select strong branches separated by several inches along the trunk and at distances as nearly equal as possible around it.

Where these main branches are allowed to grow near the same point on the trunk, a pocket which will hold water and collect dust, falling fruit, and leaves is often formed within a few years by the increasing diameter of the branches. This makes an easy entrance for wood rots and results in the loss of many limbs and the weakening of others, so that they are easily broken down by heavy loads of fruit or by windstorms. Where four or five main branches are allowed to grow in forming the tree, the danger of the formation of such a pocket is obviously increased (fig. 28).

FIGURE 28.—A plum tree composed of several main limbs which started from points close together on the trunk. As the limbs increased in size a pocket was formed where they came together. Wood-decaying organisms found entrance here, thus weakening the limbs, some of which have broken down.

To induce further branching of the young tree, the limbs which develop the first season after the tree is planted are, in turn, cut back the following winter, or they may be lightly pinched back during the summer when they have reached the desired length. The same practice is followed in succeeding years to induce further branching.

Superfluous branches should be rubbed off when they first appear, or they should be removed not later than the winter after their first season's growth. In selecting the branches which are to remain, much can be done toward directing the shape of the tree and developing a formation that will enable it to hold heavy crops of fruit. Where too many branches are left or some have grown at an undesired angle they may be removed, so as not to interfere with the best development of the tree.

With top-grafted trees, much can be done toward establishing the framework the first year, as at this time the new wood makes a

vigorous, rampant growth and may be pinched back three or four times during the summer, thus establishing as many points of branching (fig. 29). Such pinching back causes the growth of a great number of branches, and those not needed may be removed when

FIGURE 29.—Three-year-old President plum grafts top-worked on a peach tree. The new plum growth was pinched back three or four times during the first season after grafting. This caused the growth of many branches that season, some of which should be removed.

they appear or may be left until the regular time for pruning during the dormant season.

Many have followed the custom of severely heading back all varieties of plums each winter until a considerable production of

fruit is reached, in order to favor the development of a stocky vigorous tree, but this system is being gradually abandoned except for the first year, after which the branches are only thinned out or cut to laterals to form a more open tree. In this way the young tree makes a greater growth and comes to bearing earlier than where severely cut back each winter. The practice of cutting back to laterals and removing only superflous branches is coming into more general favor on irrigated lands where soils are fertile and a thrifty new growth is assured. The old method of pruning is still used in some sections, especially in nonirrigated orchards where new growth is slow and for some varieties which are spreading in their habits of growth, grow slowly, and are not naturally vigorous.

In the pruning of bearing trees there is considerable divergence in practice. With varieties grown for prunes the branches, as a rule, are thinned out rather than cut back, and in many instances no pruning is performed or only dead branches are removed. Where the trees are grown for the fresh fruit, more thinning out is done with many varieties, especially the Japanese sorts, and in some sections severe annual cutting back is customary. On the thinner and poorer soils and in nonirrigated sections the practice of cutting back the 1-year wood is more general than elsewhere. Methods favored or particularly successful in one locality are naturally carried into neighboring ones, although conditions for wood growth there may be decidedly different and poor results may follow. The annual wood growth is normally short on the drier soils; on all but the deeper soil types in such places varieties for the production of fresh fruit are grown. Good prices for the fruit can be realized on large sizes only, and severe cutting back of the previous season's wood growth is relied on to insure large sizes of fruit. In some dry places where the annual growth is normally short, even on heavily pruned trees, if cutting back is not practiced it will be exceedingly short after a year or so, and poor production and lack of vigor in the tree may be expected.

On irrigated soils which are considered insufficiently deep for planting to varieties for prune making but where plums for fresh shipment are grown extensively, cutting back the new wood is widely practiced. Under these conditions some growers cut back lightly the growth of the previous year and with varieties of the domestica group confine their pruning mostly to the thinning out of branches. With the Japanese plums, which are naturally vigorous growers and bear their fruit on spurs on wood of all ages, more cutting back of 1-year-old wood, as well as the thinning out of branches, is practiced, to insure a vigorous wood growth and large-sized fruit. In this instance pruning is used partly as a means of thinning the fruit or, rather, of reducing the crop and distributing the load over the tree. Where heavy cutting back is practiced the trees are called upon to produce a crop of both wood and fruit. The soil cannot be expected to sustain a profitable orchard where the toll for each is heavy.

Trees of the Agen and Italian Prune, the two principal varieties grown for prune production, bear most of their fruit on wood 1 and 2 years of age. A thrifty wood growth should therefore be made by the tree each year. If not thinned out or occasionally cut back, the twigs soon become too numerous for the tree to produce a satisfac-

XUM

tory terminal growth, and a poor terminal growth results in small or irregular crops of fruit. On the other hand, removing too much bearing wood will naturally prevent a good crop the following year. Under conditions most favorable for wood growth by varieties which naturally make a strong growth, less thinning out of the twigs will be necessary. Where thinning out the branches and occasionally cutting the terminal growth back to laterals is not sufficient to induce the growth of several inches of vigorous new wood at the ends of the twigs during the summer, a change in methods of culture should be resorted to for stimulating more vigorous growth.

The growing and fruiting habits of the individual varieties should be closely observed and should guide the pruner in his work. Varieties inclined to make a compact upright growth, such as the Santa Rosa or Wickson, should be pruned to induce spreading. Those naturally spreading, such as the Burbank, should have their long lateral-growing branches shortened to facilitate cultivation and to encourage the growth of strong upright branches which can carry a heavy load of fruit and provide shelter from the sun for the main trunk. Varieties which bear fruit on spurs on older wood should be kept open for the admission of sufficient light to develop fully the foliage of such spurs. This can be accomplished best by moderately thinning out the new wood. Severe cutting back will result in a vigorous new growth, which tends to shade and prevent spur development. Too little pruning, on the other hand, often results in the stagnation of growth of these spur-forming varieties, with consequent poor production. Excessive pruning of the upright-growing varieties of Japanese plums causes a rampant growth and a tendency to form long barren poles, on which fruitfulness is delayed, even if spurs form on them at all. Among varieties which under good growing conditions make some terminal growth on which they bear most of their fruit the following year there are variations in tendencies which should not be overlooked in pruning. Excessive cutting back will cause a heavy new growth with these as with other varieties, while no pruning tends to cause the formation of spurs and inactivity of growth of such spurs. This occurs at least on varieties or individual trees where little or no terminal growth is made, with a resulting decrease in fruit production. With the dying out of some spurs and the loss of others broken off in harvest and cultivation, the fruit-producing portion of the tree is seriously reduced year by year. This is naturally most apparent where the orchards are on poor soils or where there is a shortage of soil moisture.

With some varieties a short terminal growth with occasional branching continues without the formation of spurs or any upright vigorous growth, and gradually long, slender, drooping masses of unfruitful twigs will develop. Trees of the Italian Prune often illustrate this. These differences in habits in the growth of wood and fruit spurs may be well illustrated by the Agen and Pond varieties, and by the Giant, which is a cross between them. The Agen variety, if left unpruned, will continue the growth of all its branches with a gradually shortening annual wood growth, and at the same time the fruit gradually will decrease in size, provided good crops are matured. When left unpruned the Pond will quickly stop its terminal growth. The dying out of many spurs and the poor leaf growth of

others exposes the fruit and wood to the sun, often resulting in sunburning. The Giant, although losing some of its spurs, will continue a fairly vigorous growth of all its terminal branches and twigs and produce a good crop of normal-sized fruit.

It should be remembered in all pruning that the work should be carefully performed with sharp tools. Where a wound is made which will not heal over quickly, as when a stub is left that is too long, or split branches are not removed, or where the bark is torn or a wound left by the removal of a large branch, there is danger of the entrance of wood decays. The careful selection of branches when shaping the young tree and later in pruning, so as to make unnecessary the cutting out of large branches, and the careful manipulation of pruning tools will prevent serious losses later.

FRUIT THINNING

Thinning the fruit is often important in plum culture. It is seldom practiced where the fruit is grown for prunes, but most varieties cultivated for their fresh fruit require it. Thinning is done primarily for the purpose of allowing the fruit which remains on the tree to become larger, so that higher prices may be received for it, but thinning also relieves the tree of some of its weight and tends to prevent the breaking of branches and to reduce the number of crops required, thereby better enabling the tree to bear regular crops of fruit. Pruning out superfluous twigs during the dormant season and also after the fruit has set is a cheap and efficient means of decreasing the load of fruit, but hand thinning, in order to leave the fruit properly spaced on the tree, is often necessary. Hand thinning should be done as soon as all danger of spring frosts is over, so that the tree may be relieved of its excessive burden as early as possible.

Thinning is necessary almost every season with some varieties of the Japanese group, such as Beauty and Burbank, and is less so with many varieties of the domestica group.

PROPPING AND BRACING

Artificial supports are often necessary to prevent the breaking down of fruit-laden branches. Slender boards are used for this purpose and are put in place when the branches start to bend with their burden of fruit.

Wires to fasten opposite branches together, thus preventing their being broken by loads of fruit, are used in a number of orchards. This means of support is considered by many a satisfactory substitute for the use of wooden props. A number of methods of using wire for supporting branches are employed, the most common being to fasten a small wire to the large branches and connect them to a ring in the center of the tree. If it is not convenient to fasten the outer branches to the center ring they may be wired to a branch which has been given support. Connecting the outer branches with a wire without the use of a ring in the center is a method favored by some.

The use of wire supports has the advantage of requiring but a small outlay for material, is fairly permanent, and does not interfere with cultivation, irrigation, and fruit picking, as do wooden

XUM

props. There is often loss of branches by breaking where props are loosened and fall when strong winds sway the trees. This is avoided by the use of wires.

Where weakness is found, occasioned by an unsatisfactory crotch, or where a large limb has been partially split down, long bolts put through the trunk or limb have been used for giving permanent support.

The necessity of branch supports may be partly eliminated by pruning, so that wounds will heal quickly and in a manner to develop a strong framework, by thinning the fruit, and by preventing injuries to the tree from sunscald and diseases which cause wood decay.

FERTILIZERS

Wherever animal manures have been applied to plum orchards in the Pacific States excellent results have followed. Owing to the shortage of such fertilizers, however, comparatively few orchards have been so treated. Quickly available forms of nitrogen are used by some growers to improve tree growth and to increase the size of the fruit. They have also been used in a number of instances to cause a heavier setting of fruit. For this purpose fertilizer is broadcast about the trees 3 or 4 weeks before the blossoms appear. Many growers claim that decided benefits have followed from this treatment.

FRUIT HARVEST

The plum harvest starts as soon as fruit enough to warrant a shipment reaches sufficient maturity to ripen while in transit to the market. This is late in May for the earliest varieties in some sections of California. The harvest of other varieties continues until August in that State and until late in September in some places in Washingon where summer temperatures are lower. With some of the Japanese varieties, the fruit of which is very juicy and therefore easily bruised, little delay can be allowed for harvesting after the fruit reaches shipping condition. Many of the domestica varieties, however, have a texture which enables them to become nearly ripe on the tree and still reach distant markets in good condition. Fruit that ripens slowly in sections where summer temperatures are moderate or low is sometimes allowed to remain on the tree for a period after reaching maturity, without injuring it for market.

Under average conditions plums ripen unevenly over the tree. Therefore two or three pickings must be made, although one or two may be sufficient for varieties where the fruit is allowed to become well ripened before picking. Harvests are usually 3 or 4 days apart, but this period is determined by weather conditions and the variety.

As badly bruised fruits and those with broken skins are not suitable for shipment, care must be exercised in picking and packing the fruit. In harvesting, the pickers take the fruit from the tree by hand and place it in baskets or buckets for hauling to the packing house. Light ladders are used for reaching the fruit on the tall branches.

In the packing shed where the fruit is to be graded by hand it is very carefully poured into bins on packing tables, where it is sorted to size and defective plums are removed as the fruit is placed in the containers for shipment. This sorting requires considerable

time, and often much of the bloom that covers the plums is rubbed off, seriously detracting from the appearance of the fruit. Excellent packages, however, are often put up where the grading is done by hand. Machines for grading plums to size rapidly and with but little if any serious bruising have come into common use.

For shipping the fruit a crate holding four tin-rimmed veneer baskets is the container most commonly used in California, although crates, fruit boxes, and lug boxes of different sizes are also used. In Idaho the half-bushel basket has largely replaced other containers. In central Washington the major part of the crop is shipped in the 15-pound lug box.

As a rule, each orchard or farm has its own packing house, which is conveniently situated in or near the orchard where the fruit is

FIGURE 30.—A 3-tunnel drier typical of those used by many prune growers in the Northwestern States.

packed and loaded on trucks for transporting to the shipping station, although a number of packing houses designed for packing fruit from several orchards are operated during the fruit-packing season.

Laws regarding the quality of fresh fruit and the shipping containers are operative in each of the Pacific States and enforced by county, district, or State officials.

The prune harvest is more cheaply and quickly accomplished and with less care than is the plum harvest. The fruit is allowed to remain on the tree until it is thoroughly ripe and is falling off of its own accord. Where jarring is necessary to cause the fruit to fall, it is done by striking the branches with light poles or padded clubs. The fruit is gathered by hand from the ground or canvas on which it falls and is placed in lug boxes for hauling to the drying yard.

Owing to the natural humidity and fall rains, the entire output of prunes in Washington, Oregon, and Idaho must be dried artificially.

In California the period during which prunes are dried is usually hot and dry, and about one-half of the crop is cured in the sun (figs. 30,

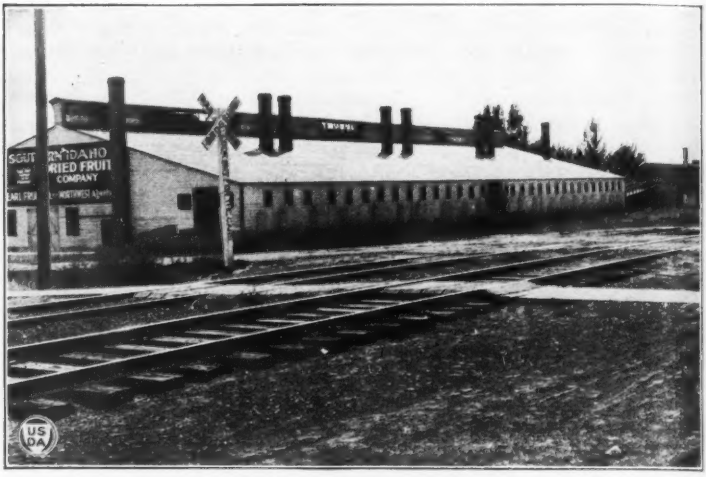

FIGURE 31.—A modern large-capacity prune drier and processing house combined. (Idaho.)

31, and 32). During recent years artificial evaporation has come into extensive use there as an insurance against the loss of fruit from rain. This method of drying is thought to be somewhat more ex-

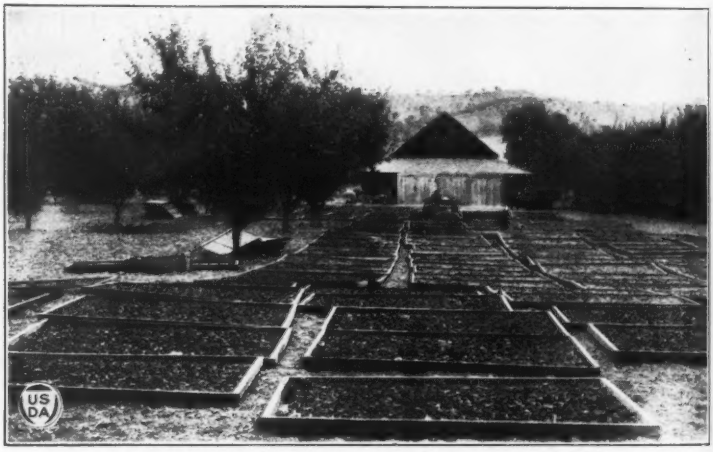

FIGURE 32.—A prune-drying yard in central California.

pensive than open-air drying, but in case of early fall rains it enables the grower to dry his crop without the loss of fruit. It also permits

the use of dry yards for orchard or other purposes and, when properly carried out, gives a more uniform and cleaner product. The practice is increasing. About half of the State's prune output is now handled in modern mechanical dehydrators. After drying, the fruit is taken to the processors to be prepared for market.

DISEASES AND INSECTS

A number of diseases and insects attack the plum and prune in the Pacific States. They are amenable to control or preventive measures, with which the grower should become familiar in anticipation of having eventually to make use of them.

The principal diseases include brown rot, which causes decay of the fruit and may affect the small twigs and spurs, or even the blossoms; leaf spot and shot hole fungus, which attack the leaves; and heart rot and oak root fungus, which attack the tree. Other diseases may occur, but those mentioned are usually the most common.

The diseases affecting the fruit and foliage are held in check by spraying; those affecting the woody parts of the tree are subject to preventive methods only.

Heart rot is a rather general term commonly applied to the results of wood-decaying organisms which find entrance to the heart of the tree through long stubs left in pruning, bad crotches, or pockets resulting from improperly formed tree tops, or wounds made in other ways. Preventive measures consist obviously in avoiding or eliminating those means through which the fungi causing decay enter the tree.

Oak root fungus is common on roots of oaks indigenous to some of the fruit districts of the Pacific States. The roots of many fruit trees are likewise susceptible to this disease. Where it occurs the only practicable course is to leave the infected areas unplanted or to plant pears propagated on French roots or figs (where these fruits are adapted), since these are about the only fruits resistant to this disease. California black walnuts are sometimes planted in such instances, to be top-worked later to the Persian walnuts.

Among the most destructive insects that attack plums and prunes in the Pacific States are the peach-tree borer, San Jose scale, red spider, thrips, twig borer, brown apricot scale, and black scale. These, with a few of less general importance, cause heavy losses annually to the plum and prune producing industry.

As climatic and other conditions vary greatly in different regions and localities, the plum grower should apply to his State agricultural experiment station for advice regarding preventive and remedial measures to be employed for the control of injurious insects and diseases with which he is likely to have to contend. Information may also be obtained from the United States Department of Agriculture.

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rev. Feb. '43

PLUM and PRUNE GROWING in the PACIFIC STATES

XUM

IN ITS VARIOUS FORMS the plum is more widely distributed throughout the country than any other tree fruit, though in value the plum crop is exceeded by that of four other fruits—the apple, peach, orange, and grape. The great range of distribution, however, is mainly incident to the great diversity that occurs in the species of native wild plums, cultivated horticultural varieties of which are found in almost every nook and corner of the country.

Though the native plums give vastness in range of plum culture in general, it is the domestica or European varieties, the Japanese sorts, and those that have originated as hybrids between Japanese and native plums that constitute the commercial industry. Prunes are included in the domestica or European group. Some of the Japanese and hybrid varieties are grown very widely, possibly as widely as the varieties of any one species of native plum.

Though this bulletin is regional in its direct application, it has to do with a very large part of the plum and prune industry, as practically two-thirds of all the plum and prune trees in the country are in California, Oregon, Washington, and Idaho.

Washington, D. C.

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PLUM AND PRUNE GROWING IN THE PACIFIC STATES[1]

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CONTENTS

	Page		Page
Plum and prune growing regions	1	Stocks used in propagating plum trees	24
San Francisco Bay and central California coast counties	3	Top working	26
Interior valleys of central California	4	Distance for planting	35
Western Oregon and western Washington	7	Nursery trees for planting	36
Eastern Oregon, eastern Washington, and Idaho	9	Time for planting	36
Choice of locality and site for a plum orchard	11	Orchard culture	37
Soils	11	Irrigation	39
Climatic conditions	13	Cover crops	42
Site and location	16	Intercrops	44
Varieties	18	Pruning	46
Varieties of plums and prunes in the Pacific States	20	Fruit thinning	51
Pollination	23	Propping and bracing	51
		Fertilizers	52
		Fruit harvest	52
		Diseases and insects	55

PLUM AND PRUNE GROWING REGIONS

THE AREA which may be utilized for the culture of plums and prunes in the Pacific States is very much limited when compared with the gross area of these States, as orcharding is restricted to tillable lands that are under irrigation or to locations where the winter rainfall is sufficient for the needs of the trees.

These requirements have resulted in limiting the commercial growing of this crop to certain sections, although in some of those sections plums and prunes are among the most important fruits produced. These sections, widely separated in distance and in climatic conditions, are discussed here separately as far as possible. Natural geographical

[1] In this bulletin the plum and prune are considered one fruit, and botanically the European or domestica plum and the prune belong to the same species, *Prunus domestica*. The cultural methods are the same, but the methods of harvesting and handling the fruit are or may be different, depending on the use to which the fruit is put. The use of the terms "plum" and "prune" dates back for several centuries. The words come from different sources, one being Anglo-Saxon, the other French. Originally they doubtless were synonymous in meaning. At what date the term "prune" was first used to designate a "dried plum" or a plum capable of being dried into a product having certain desirable characteristics is uncertain; however, this term has come to signify a plum which is capable of being dried without fermenting when the pit is not removed. The term also signifies the dried as well as the fresh fruit. A prune, therefore, is substantially a variety of plum which possesses certain peculiar characteristics. Most plums, if dried with the pits remaining in them, would ferment in the process. Prunes, in the fresh state as compared with plums, possess a firmer flesh, a higher content of sugar, and frequently a higher acid content; in other words, a prune is a plum having these characters in a more marked degree than other plum varieties. Large quantities of fruit which could be dried to prunes are sold in the fresh state; they are then handled in the same way that plums are handled. Plums are sometimes dried after the pits are removed, but the product is called "dried plums," not "prunes." In case of varieties that can be dried to prunes, the fruit in the fresh state, as indicated above, is often called a prune; and in some instances the word "prune" is a part of the variety name, as the Italian Prune or German Prune.

XUM

divisions are used for boundaries of the regions where phases of the industry, such as marketing and cultural methods, differ sufficiently to warrant separate consideration.

The boundary of each of these regions to which some phase of the industry is peculiar is determined largely by prevailing temperatures, although, within a given region, soil conditions and the availability of water for irrigation result in considerable divergence in methods of carrying out details in orchard management. Although this crop (plums and prunes considered collectively) may be found in home orchards of all sections of the Pacific States, four geographical districts may be said to include the principal commercial producing areas of this fruit. These are (1) the San Francisco Bay and central California coast counties, including the Santa Clara, Napa, and Sonoma Valleys and their tributary valleys and adjacent foothills; (2) the interior valleys of central California, including the Sacramento, San Joaquin, and tributary valleys, and the bordering slopes and foothills; (3) the principal river valleys and the adjacent rolling lands of western Oregon and western Washington, including the Willamette, Columbia, and Umpqua River Valleys; and (4) the irrigated valleys of southeastern Washington, northeastern Oregon, and the Snake River Valley region of Idaho. With this last section is included also the region of east-central Washington and the bordering portion of Idaho known as the Palouse region, which lies in the same geographical district as southeastern Washington, although cultural practices differ decidedly in the two sections.

Plums are grown commercially also in southern California, principally in Los Angeles and Riverside Counties, but here they are not among the more important fruit crops. In the four divisions specified there is produced almost the entire commercial output of plums and prunes in the Pacific States, although the plum is widely planted for home use, and a large list of varieties is represented in the home orchard in all fruit-growing localities of these States.

In each of the four main districts some phase of plum culture is practiced which is for the most part distinct from that of the other districts, these differences being made necessary by the peculiar climatic conditions of the district. The main features in the culture of this crop that are peculiar to each district may be summarized as follows:

(1) The San Francisco Bay and central California coast counties include the principal centers in this country for the production of the Agen, commonly called the French prune or Petite prune, and of the Imperial Epineuse prune. In this district these varieties are grown in far greater quantity than all other varieties combined, and owing to the warm, dry fall climate the crop of prunes may in most seasons be dried in the open air. The larger portion of the orchards in this district is under irrigation.

(2) The interior valleys of California produce plums both for shipping fresh and for making into prunes. Practically all the varieties of plums and prunes grown in the Western States are represented here. Most of the acreage in this district is under irrigation.

(3) In western Washington and western Oregon the Italian Prune and the Agen are the only varieties of wide commercial importance among the rather small list grown, the Italian Prune being decidedly the more important of the two. Part of the crops is canned fresh and part is dried to prunes. Practically all the orchards of this district are grown without irrigation.

(4) In the district east of the Cascade Mountains, including southeastern Washington, northeastern Oregon, and Idaho, the Italian Prune is by far the most important variety, almost the total crop being shipped fresh to distant

markets. The entire acreage in this district is under irrigation except in the Palouse region, where the Italian Prune is the only commercial variety and all orchards are maintained by dry-farming methods. The fruit in the Palouse region is usually dried into prunes by artificial means, but some fresh fruit is shipped to distant markets.

For convenience in describing the commercial distribution, the prevailing cultural practices, and the economic conditions in plum culture, the districts above-mentioned are considered separately.

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES

The first district includes the cultivated areas of the Santa Clara, Sonoma, and Napa Valleys and their tributaries, or the valley areas of Santa Clara, San Mateo, San Benito, Sonoma, and Napa Counties.

FIGURE 1.—Orchard of Agen (*French prune*) prunes growing in a fertile valley soil, Healdsburg, Calif.

Varieties for prune making are grown throughout these valleys and to some extent throughout the adjacent lower slopes and foothills, with centers of production near San Jose, Napa, and Healdsburg. A few plums for the fresh market are grown here, and a few are grown for canning (fig. 1).

Since 1875 plum and prune planting in this district had gradually increased up to a few years ago, except for a few interruptions due to low prices of the product. During the past few years new plantings have been light, and almost all of the orchards are now in bearing.

The Santa Clara Valley, the first center of the prune industry in this country, is still the principal center of production, with more than half the prune trees in the district, mostly in Santa Clara County. Nearly one-fourth of the prune trees in this district are in Sonoma County.

The soils devoted to plum and prune production in these valleys are, for the most part, the deep fertile loams and sandy loams which are darkened by a moderate humus content and are easily handled, productive, well-drained, and enduring in nature. Small areas of adobe soil are found, and in certain sections the soil moisture becomes excessive in some years, requiring drainage for the most satisfactory tree development. The summers are long and warm, and, as in all fruit-growing sections of the Pacific States, the summer rainfall is exceedingly light through the plum-growing season. Irrigation is practiced wherever water is available and facilities for its application have been provided. During the period for drying fruit, in September and early October, occasional interruptions are caused by rains, which make it necessary to stack the drying trays, and even with this precaution loss of fruit is not always avoided and is sometimes considerable. With ordinary caution, however, in most years the crop may be dried in the open with but little, if any, loss. As an insurance against damage by rains, artificial driers were introduced a number of years ago, and now about one-half of the crop is dried artificially. The temperature throughout the prune-growing sections of this district is very much the same through the fruit-growing season, except that the daily range is somewhat greater during the warmest part of the summer in the portions of the main valleys which are farthest from San Francisco Bay.

Aside from the Agen, which is the principal variety in all sections of this district, the Imperial Epineuse is grown to a considerable extent in the Sonoma Valley, especially in the plateaus bordering the valleys near Healdsburg. Throughout the district the Sugar and the Standard are varieties of some importance. The culture of plums for shipping fresh is not an important industry here, mainly owing to insufficient warmth during the early summer to ripen them so that they may be marketed in competition with the plums from sections where they ripen earlier. In some localities of this district there is also a lack of water for irrigation, which is needed to produce fruit of the larger sizes suitable for shipping.

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

The interior valley district includes the Sacramento and San Joaquin Valleys of California and their bordering slopes and tributary valleys. Plantings, which total more than 58,000 acres, are found in all localities of this district where plums and prunes are cultivated, with three-fourths of the plantings in the Sacramento Valley. The largest centers of production are the Loomis-Auburn section of Placer County, the vicinity of Vacaville in Solano County, the Hood-Walnut Grove section of Sacramento County, in Tulare, Fresno, Kern, and San Joaquin Counties, along the Feather River in Sutter County, and near Chico in Butte County. One-third of the plum trees in this district are in the first two sections mentioned. All other counties of the district include plums among their fruit crops.

The plums that ripen first in the Pacific States are produced in the plum-growing sections of this district where there are extensive

plantings of early-maturing varieties. The first harvests are made in the southern end of the San Joaquin Valley near Bakersfield and a week or so later in the foothills of Solano County, near Vacaville. Fruit of the earliest varieties is shipped to eastern markets during the latter part of May. The harvest in the foothills of Placer County starts but a few days later and is followed closely by that in the sections throughout the main valleys.

While the low winter temperatures are approximately the same throughout the district, the localities where the earliest fruit is produced are naturally protected in the spring from the cool, moist breezes, which sweep through the main portions of the lower valleys, and their surface soils are well-drained and friable, and absorb heat well. These conditions result in the early blossoming of the trees and the rapid development of the fruit.

Plums both for fresh shipment and for prune making are grown extensively in all the large fruit-growing centers of the district except in Placer and Kern Counties, where the entire output is fresh fruit. In Butte, Colusa, Tehema, Glenn, and Yolo Counties the acreage in this

FIGURE 2.—A plum orchard on delta land in the lower Sacramento Valley, Calif. Note the close planting and vigorous growth of the trees. A small portion of the river levee is shown at the left.

fruit is devoted almost exclusively to prune production. Over nine-tenths of the plum trees of this district are of bearing age. Vast areas suitable for this fruit are now occupied by annual crops or are not under cultivation, a result largely of the lack of irrigation systems.

The soils devoted to plum culture in this district are those of the deep, fertile, alluvial types in the valley bottoms (fig. 2). In the higher lands there is a wide range of type varying from heavy deep loams to sandy and gravelly soils, where the underlying stone is sometimes covered with only a shallow layer of tillable earth. Soils underlaid near the surface by hardpan, which occupy broad areas in the main valleys, are avoided almost entirely for varieties for prune making and are naturally unsuited to varieties for fresh shipment. Soils derived from granite and some types of sandstone, such as are sometimes found in the rolling foothills bordering the large valleys,

are fertile and well-drained and are in demand even where the stratum of tillable soil is not deep.

Notable among the nonirrigated sections is the rolling area near Vacaville, in Solano County (fig. 3), where the foothill soils are derived from and underlain with sandstone. If properly tilled, these soils are sufficiently retentive of moisture to produce profitable crops of fruit without irrigation. As no water is available for irrigation in this section, dry-farming methods are practiced.

In this district the summers are long, hot, dry, and well suited to the early ripening of plums as well as for the satisfactory development of prunes. As a rule the summer drought continues well into the autumn, so that prunes may be dried in the sun without loss from fall rains. However, the fear of damage by fall rains has resulted in the construction of dehydrators, which now care for the

FIGURE 3.—Plum orchards on the rolling lands near Vacaville, Calif. The season's earliest fresh-fruit shipments to eastern markets are made from orchards on these lands.

drying of a part of the crop. The early warmth in the spring causes the trees to blossom early, and some injury by frost, at least to the early blooming varieties, is not uncommon in the lowlands. Here the annual rainfall varies considerably from year to year, but there are no rains during the fruit-growing season. Irrigation is therefore imperative in the shallower soils and highly desirable on the deeper valley soils not moistened by subirrigation. In some places in the Hood-Walnut Grove section of the lower Sacramento Valley, orchards are usually plentifully supplied with moisture by subirrigation.

As in the central California coast counties which have just been discussed, the Agen variety is by far the most important for prune making, although orchards of the Imperial Epineuse, Standard, Sugar, Sergeant (*Robe de Sergeant*), and a few others are occasionally found. Almost all varieties of plums grown commercially in the Pacific States for fresh shipment are found here in considerable quantities.

WESTERN OREGON AND WESTERN WASHINGTON

The principal commercial plum-growing centers of western Oregon and western Washington lie in the cultivated areas between the Cascade and Coast Ranges in western Oregon and west of the Cascade Mountains and the Puget Sound section of Washington. Until the late eighties plum growing was a minor industry in this district, but about that time it became popular and most of the older orchards were established. Plantings had not greatly increased until within the past 20 years, when many orchards have been established or old ones enlarged.

The principal plum-growing sections in Oregon are in the vicinity of the Willamette River in Marion, Polk, and Yamhill Counties, with centers near Salem, Dallas, and Newberg, and in the Roseburg-Riddle section of the Umpqua River Valley in Douglas County, where the plantings are about the same in extent as in the different counties

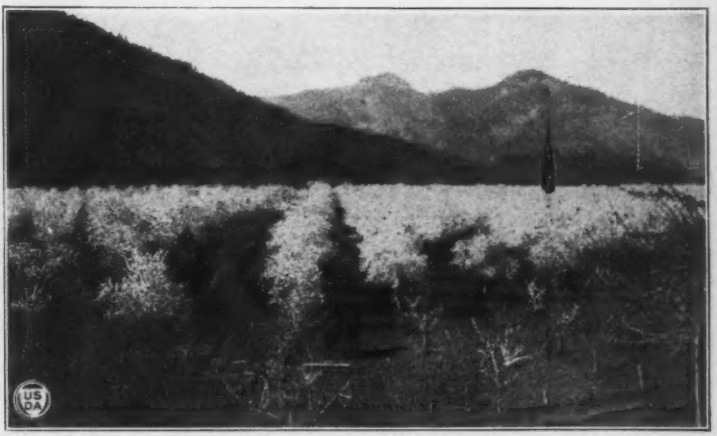

FIGURE 4.—A prune orchard in bloom in a rather narrow valley location, Umpqua Valley, Douglas County, Oreg.

farther north just mentioned. More than three-fourths of the prune trees in western Oregon are in these four counties.

In western Washington the principal plum-producing section is the Vancouver-Camas-Washougal section of Clark County.

The greater portion of the orchards in the Umpqua Valley are in the bottom lands near the river, while in the Willamette River Valley region the rolling lands have been as much favored as the low valleys for prune production (fig. 4). Many growers have given preference to the broken, rolling lands which reach 500 or more feet above the river bottom (fig. 5). In the prune-producing sections of Washington just mentioned, both the flat lands near the Columbia River and the rolling lands extending back several miles from it and in the Puget Sound region are used.

Many soil types are represented in the orchards of this district. Through the sections in Oregon brownish or reddish clay loams pre-

dominate, with subsoil heavier in texture but of the same material, which has been derived from the basalt rock with which it is underlain. In the lower valleys, notably that of the Willamette River, the humus content is rather high and the soil is loosened and darkened by it. This soil is deep and retentive of moisture. Through the red and brown soils of the rolling orchard sections the humus content is low, and the surface soil dries out rather quickly and is sticky when wet. When cultivated while too wet, it forms compact clods which are very hard when dry, but if this soil is tilled when in proper condition it works up into a light loam of excellent quality.

The surface soils in the plum-growing sections of southwestern Washington are, for the most part, sandy or gravelly loams, light brown, brown, and gray in color, underlain at a varying depth of about 3 feet and over with a deep stratum of very coarse gravel.

FIGURE 5.—A typical site of a prune orchard in the broken rolling section of northwestern Oregon.

This soil is easily tilled but is not retentive of moisture because of the excellent subdrainage. In the prune-producing sections farther back from the Columbia River the subsoils are finer in texture and more compact, and therefore more retentive of moisture. Soils built up by washings from the Columbia River and similar soils of the rolling section to the northeast of Vancouver Lake in Clark County, Wash., are deep, fertile, fairly retentive of moisture, and are prized for prune production (fig. 6).

In this district the rainfall is heavy during the fall, winter, and early spring, but drought prevails during the summer, the same as in most cultivated areas of the Pacific States. Almost no irrigation is practiced in this district, although the need for moisture is apparent during the late summer throughout most of the large orcharding areas, especially in rolling sections where the humus content is low and in places where the substratum of coarse gravel comes to within a few feet of the surface. There is some variation in the length of the dry season in different years. The rains sometimes start while the prune harvest is in progress and occasionally con-

tinue in the spring until the trees are in blossom. Injury to the crop results in either case.

Low temperatures have caused serious injury to the trees in northwestern Oregon and southwestern Washington, at least in the lowlands. The summers in this district are warm, but several degrees cooler than in the central California valleys and somewhat cooler than in the plum-growing centers of the valleys of California near the coast or of those of eastern Washington, eastern Oregon, and Idaho.

No plums are shipped fresh to the eastern markets from this district because of the moist atmosphere at harvesttime, with the resulting prevalence of brown rot. Although the major portion of the crop is dried, large quantities of fruit are canned fresh. The canned

FIGURE 6.—A comparatively old orchard of the Italian Prune in Clark County, Wash., near Vancouver. Trees planted 20 by 20 feet. The orchard has been well fertilized and tilled and produces well.

plum is an excellent product and is gaining in popularity. The total output of prunes is cured artificially, owing to the moist fall weather, which makes open-air curing impracticable.

The planting of plums has been confined largely to the Italian Prune variety, although a number of orchards of the Agen (or the Petite prune, as it is commonly called in the Northwestern States) are found. The proportion of the Agen prune is greater in Oregon than in Washington, especially in Douglas County. There are a few orchards of Sugar, Imperial Epineuse, and Standard prunes, but the output of these varieties is not important at present.

EASTERN OREGON, EASTERN WASHINGTON, AND IDAHO

The planting of commercial orchards of plums in the district embracing eastern Oregon, eastern Washington, and Idaho has been

confined almost entirely to the irrigated valleys, with important centers of production near Walla Walla, Walla Walla County, Wash.; the Milton-Freewater section in Umatilla County, Oreg.; the Yakima Valley in Yakima County, Wash.; and the Weiser-Emmett-Boise section in southwestern Idaho. Prunes are grown commercially, but not very extensively, in northern Wasco County, Oreg., near The Dalles, in eastern Whitman and southeastern Spokane Counties, Wash., and the bordering portion of Idaho, known as the Palouse region. There is no water available for irrigation in the last two sections, but orchards are maintained by dry-farming methods. Since the early nineties, when the major portion of the oldest plum orchards of this district were established, the growth of the industry has been slow until within the last 25 years, when extensive plantings were made. The Walla Walla, Milton-Freewater, and Yakima sections are centers where extensive new plantings were made during and following World War I. The increase is less marked in the fruit-growing portions of Idaho. But little planting has been done in any of these sections during very recent years, and now over 95 percent of the trees are of bearing age.

The soil in which fruit is grown in this district is, for the most part, a fertile, friable, easily tilled sandy loam of varying depth and organic content. It is everywhere sufficiently deep for good tree growth, and in some places, notably in the Yakima Valley, it is exceedingly deep. The surface soils are open and well drained, and the subsoils in most places are composed of stratified materials and are well drained also.

The sections from which plums are shipped from this district are semiarid to arid in nature. The summers are somewhat shorter than in the plum-growing sections of western Washington, western Oregon, and California, and the days are hotter than in western Oregon and western Washington, with the daily range of temperature greater. The rainfall is light, nearly all of it occurring from September to April. The total precipitation is considerably less than in the other districts described, except in the Palouse region. The fruit reaches good size and, owing to dry weather which usually prevails at harvesttime, may be successfully shipped to distant markets.

In the Palouse region, where the prevailing summer temperatures are low, the rainfall light, and only moderate cultivation is given, the fruit is usually below the sizes sent to the market fresh. A portion of the fruit from this region is shipped fresh when the prices for fresh fruit are high or the fruit for the season is above the average in size.

As in the sections farther west, the Italian Prune is by far the most widely used variety and the best for general planting. A considerable number of orchards of Pond, Tragedy, California Blue (Vacaville), Standard, and a few other varieties are found. The greatest acreage of varieties other than the Italian Prune is found in the Yakima and Walla Walla sections. In the Yakima district Japanese varieties or Japanese-American hybrids are grown to some extent, and the acreage devoted to them is increasing. Until recent years these varieties were grown in an experimental way only. Santa Rosa, Climax, and Burbank are the most popular of these

varieties. In southern Idaho the Italian Prune is grown practically to the exclusion of others.

The harvest of the Italian Prune for fresh shipment in this district starts about August 10 in the section near The Dalles, Oreg., and is followed in a week or so by that from the main irrigated centers.

In case of an unsatisfactory market for fresh fruit or if the fruit is small in size, a part of the crop is dried. All fruit for drying is processed by artificial means, the work often being done in central desiccating plants rather than in the small individual orchard driers.

CHOICE OF LOCALITY AND SITE FOR A PLUM ORCHARD

The plum is adapted to a wide range of soil and climatic conditions and is found in all sections where fruits are grown in the Pacific States. Prevailing temperatures in fruit-growing sections of this region are for the most part suited to commercial plum culture, though the rainfall is sparse during the summer, irrigation being necessary in some localities After the establishment of means of transportation through rural districts to central markets and the providing of means for irrigation, some points which require consideration are the selection of the proper soil type, the contour suitable for orcharding, and the locality where temperatures are congenial to the development of the variety the orchardist wishes to plant. Varieties grown for early fresh-fruit shipment are usually not types which sell well in the market with later maturing varieties and therefore should be planted where natural conditions favor their early ripening. Also, varieties grown for their dried product must be planted in places having a long growing season. Where fruit is for fresh shipment, not only the size of fruit must be considered but also the possibility of loss from brown rot. The climate must be sufficiently free from moisture at harvesttime to insure the fruit arriving in market without loss from decay in transit. The choice of a location and site for an orchard is then largely dependent upon the particular market in which the grower wishes to sell his product.

SOILS

Plums are not particularly sensitive as to soil, provided it is reasonably deep and fertile. They are found growing on a great number of soil types. The Japanese or American-Japanese hybrids, which make up a large acreage of plums grown for fresh-fruit shipment in California, will succeed on a soil more shallow and somewhat thinner than varieties of the *Prunus domestica* group, especially those which are grown for prune making. For the latter, only deep, fertile, well-drained land should be used, the heavier clay loams being preferable to the sandy loams. Soils which are underlain near the surface with hardpan should be avoided for plum culture.

Plum plantings for the most part have been made on soils derived from volcanic materials which have been laid down by sedimentation through the irrigated sections of Idaho, Washington, and Oregon; on the residual reddish clay loams and dark valley soils which have been filled in by washings from this type in western Washington and western Oregon; while in California, where the culture of this

fruit has been greatly diversified, many different soils are used. However, for the production of prunes, plantings here are confined almost entirely to the deep, dark, heavy loams such as are preferred by pear growers and which have been washed into the valleys from the surrounding hills. All varieties of plums for fresh-fruit shipment are grown in the valleys as well as on more upland soil, while those grown for their dried fruit are seldom planted on the more shallow uplands, where early shipping plums do well and have been extensively planted. For plums for fresh shipment, the more shallow, upland soils are not used except under irrigation or unless the soil type is such that it is very retentive of moisture, since a liberal supply of soil moisture is essential to the development of the large sizes demanded by the market for early plums. Notable among non-irrigated, rolling lands where plums for fresh shipment are grown is the rolling, hilly country lying in the immediate vicinity of Vacaville, Calif. Here the friable sandy loam, which is residual in origin, is well drained and open and warms quickly in the spring, and the subsoil and underlying sandstone, from which the soil has come through disintegration, is retentive of moisture, making natural conditions highly suited to the early ripening of fruit. In this region the summers are hot and dry, but the soil moisture is sufficient to bring a moderate crop of fruit to a desirable marketable size. Under these conditions the crop ripens several days earlier than in the immediately adjoining lower valley, where the deep fertile soil is more compact and slower in warming up in the spring. On the thinner soils of the hills, however, the tree growth is less than in the valley, and the crops are not so heavy as in the deeper soil.

Placer County, Calif., is situated on the western slope of the Sierra Nevada foothills, where the soil as a rule is not deep and is low in organic matter, but is open, friable, well drained, and under good cultural methods retentive of moisture. It is derived by the weathering of granite bedrock and is a sandy, gravelly loam, varying considerably in depth. Outcroppings of granite occur occasionally through the orchards, while good soil to the depth of 6 feet or more is commonly found. While plum growing is extensive in each of the localities just described, varieties for prune making have been planted very sparingly.

In the deep fertile alluvial soils in the Sacramento and San Joaquin Valleys plums for both fresh shipment and drying for prunes are grown with equal success. Here the climatic factor is the one which influences the planter most in his choice of crops. In these interior valleys, where the climatic and marketing conditions are suitable, both plums and prunes are widely grown. On soils of the same general nature in the valleys near the coast climatic conditions cause a later harvest of plums for fresh shipment, and as a result they are but sparingly planted. Here prune production is the most extensive phase of fruit culture.

The principal soils used for plums in western Washington and western Oregon are the deep, enduring types, of both residual and sedimentary origin. In these soils the organic content is low except in the river bottoms, and when dry the soil is hard and difficult to cultivate. In a few smaller centers the soils are shallow, inclined to be heavy, and not conducive to a large tree growth or regular pro-

duction of good crops. In the eastern part of these States and in Idaho, orchards are found mostly in the deep sandy loams of sedimentary origin where the settling of volcanic material has been an important factor in the formation of the surface soil, as in the Yakima Valley of Washington. These grayish mellow soils are easily tilled, very fertile, and fairly retentive of moisture when well cultivated. Where they are of sufficient depth they are suited to plum and prune production, as both good size and a development that insures a good dried product are obtained.

Strata of hard, compact material or hardpan are often found within a foot or two of the surface in some types of sedimentary soils. The grayish open surface soil in such places is usually fertile if an excess of alkali is not present, but the greatest care and judgment should be used in selecting a site in such soils. In localities where a hard stratum of subsoil appears there is danger of selecting a site where the soil is of so little depth that it will become waterlogged by the settling of the moisture into the low places in the hardpan. Or one may find a soil which does not provide sufficient depth for normal root growth for plum trees. When planted on fertile shallow soils underlain with hardpan, trees often grow well for a few years and produce fairly well while young, but an unprofitable crop of fruit or the loss of trees often follows by the time full production should have been reached.

Soils rich in nitrogen may cause a thrifty growth, but those well balanced in available plant food are necessary for the regular and continued production of large sizes of well-developed fruit. While the size of the fruit for fresh shipment can be regulated to a considerable extent by the manipulation of irrigation water, fertile soils are necessary also for the proper growth and development of fruit. Excessive irrigation often causes poor tree and fruit development, and planting on poor soil results in a crop of small fruit which will prove unprofitable, since within the variety prunes are classified almost entirely as to size when placed on the market.

CLIMATIC CONDITIONS

The plum will thrive where winters are cold and will withstand hot summers, drought, and heavy rainfall as well as or perhaps better than other common deciduous fruits. Frequent and sometimes heavy losses are sustained in some localities, however, from injury to the blossoms by late spring frosts. Some varieties of the Japanese group in common cultivation blossom early in the spring, often several days or weeks before the last frost occurs, while the varieties of the domestica group, usually blooming considerably later, are seldom injured by frost. Practically all sections of the Pacific States where plums are grown commercially are visited occasionally by late frosts, although small areas of somewhat elevated rolling lands are considered to be free from any considerable loss from them. While the plum tree will withstand a heavy rainfall, rainy and foggy weather during blossoming time hinders pollination, and rains during harvest favor the growth of fungi, causing the fruit to decay and, therefore, seriously hindering both fresh-fruit shipments and prune making. For both long-distance shipment of fresh fruit and

for drying, which are the principal objects of plum growing in the Pacific States, the long, dry, hot summers which prevail are well suited.

In western Oregon and western Washington fall rains and high humidity at harvesttime make it necessary to dry fruit artificially. Dry fall weather usually permits open-air drying in California, although serious damage to the drying crop has resulted from rain.

Summer rainfall is exceedingly light throughout the fruit-growing sections of the Pacific Coast States, but the differences in temperature between the fruit-growing sections of these States is sufficient to cause wide differences in the practices followed in orchard management. For the most profitable production of early plums of Japanese and American-Japanese hybrid varieties, the fruit should be shipped before the later ripening varieties of the domestica group, which in the earliest plum-ripening sections of California is midsummer. This is possible only where the spring and summer are warm, as the later ripening varieties mature under such conditions before the earlier ripening ones in cooler regions. For this reason the cultivation of early-ripening plums has been largely confined to the hot interior valleys of California.

The mean spring and summer temperatures of a plum section largely determine the type of plum growing carried on there. For example, fruit for fresh shipment is largely grown in the hot interior valleys, as compared with the cooler Santa Clara, Sonoma, and Napa Valleys in California, where fruit for drying into prunes is principally produced. In the cooler valleys of California the Agen prune is the principal one grown, while in the Northwestern States, where still lower mean temperatures prevail, the Italian Prune, planted only sparingly in California, is grown almost exclusively. However, in a few places in the warmer sections of these States the Agen and other varieties of the domestica group are cultivated to a considerable extent. Temperatures of the principal plum-growing sections are given in table 1, compiled from the records of the Weather Bureau.[2]

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*

[Data for representative plum and prune producing sections of each district, from the summaries of climatological data for the United States by sections for the different stations, as follows: *A*, Section 14, central and southern California, p. 22–24; *B*, section 16, northwestern California, p. 16–17; *C*, section 15, northeastern California, p. 36–37; *D*, section 17, western Oregon, p. 18–19; *E*, section 19, western Washington, p. 9; *F*, section 20, eastern Washington, p. 10; *G*, section 22, southern Idaho, p. 5]

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
		°F.	°F.	°F.	°F.	°F.	°F.	°F.
San Jose (*A*)	Maximum	63.8	69.9	72.3	76.9	80.9	79.9	79.3
	Minimum	43.7	44.4	45.8	48.7	52.0	51.2	50.0
	Mean	53.7	56.7	60.7	65.0	66.9	66.7	64.7
Hollister (*A*)	Maximum	64.4	69.2	71.5	77.2	81.2	79.8	79.1
	Minimum	40.6	41.5	43.8	46.8	48.7	49.2	47.5
	Mean	54.5	58.2	62.3	65.9	67.2	66.7	65.6

[2] U. S. Department of Agriculture, Weather Bureau, Climatological Division. Summaries of climatological data sections. U. S. Dept. Agr., Weather Bur. Bul. W, vol. 1, 1912.
——— Summary of the climatological data for the United States, by sections. U. S. Dept. Agr., Weather Bur. Reprint [Revision of Bul. W] Sect. 14–17, 19–20. [1912–18.]

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*—Continued

SAN FRANCISCO BAY AND CENTRAL CALIFORNIA COAST COUNTIES—Continued

Stations		Mar.	Apr.	May	June	July	Aug.	Sept.
		°F.	°F.	°F.	°F.	°F.	°F.	°F.
Napa (*B*)	Maximum	63.0	68.8	72.9	79.0	81.2	80.5	80.8
	Minimum	42.1	43.8	47.1	50.5	52.8	52.1	50.1
	Mean	52.6	56.8	60.8	65.4	67.6	67.0	66.0
Healdsburg (*B*)	Maximum	67.1	73.5	77.2	83.8	89.4	87.7	85.6
	Minimum	40.5	43.3	46.2	49.4	50.8	49.3	47.7
	Mean	52.1	56.9	59.9	65.9	68.5	66.5	65.7

INTERIOR VALLEYS OF CENTRAL CALIFORNIA

Tulare (*C*)	Maximum	69.0	77.5	82.4	91.7	99.6	97.2	88.8
	Minimum	40.8	44.5	49.9	56.1	60.2	58.9	52.7
	Mean	55.9	62.6	68.2	77.4	83.0	80.1	71.9
Stockton (*C*)	Maximum	60.9	67.9	73.5	82.7	88.5	86.5	81.8
	Minimum	43.2	46.6	50.0	55.6	57.0	56.5	54.8
	Mean	54.5	58.9	64.1	69.9	72.6	72.5	69.0
Chico (*C*)	Maximum	66.3	73.0	79.9	89.3	98.9	97.4	88.7
	Minimum	41.2	44.8	49.0	55.0	60.2	58.3	53.5
	Mean	55.6	61.6	68.4	77.1	83.9	81.5	74.6
Auburn (*C*)	Maximum	62.5	69.0	74.7	85.1	91.7	91.8	83.5
	Minimum	42.0	44.7	50.1	55.0	61.1	60.3	54.4
	Mean	51.7	56.5	62.7	70.8	76.8	75.9	71.0
Vacaville (*C*)	Maximum	65.9	71.5	78.5	84.1	93.5	92.1	86.4
	Minimum	42.7	45.4	48.6	51.7	55.8	55.6	52.5
	Mean	53.9	58.8	64.2	71.0	75.5	74.5	70.8

WESTERN OREGON AND WESTERN WASHINGTON

Roseburg, Oreg. (*D*)	Maximum	57.0	62.1	68.0	72.7	81.0	81.2	74.1
	Minimum	38.1	40.1	44.9	48.9	52.6	52.3	47.9
	Mean	47.6	51.4	56.5	60.8	66.9	66.7	61.1
Salem, Oreg. (*D*)	Maximum	55.1	60.9	66.3	72.0	79.6	80.1	72.0
	Minimum	37.9	41.0	45.5	49.7	53.3	53.1	48.7
	Mean	46.2	50.8	55.9	60.9	66.4	66.4	60.3
Vancouver, Wash. (*E*)	Maximum	55.9	62.5	66.8	72.7	79.7	79.5	72.8
	Minimum	37.1	39.7	45.3	49.7	53.2	52.3	47.9
	Mean	45.7	51.6	57.5	62.2	66.9	66.2	60.9

EASTERN WASHINGTON, EASTERN OREGON, AND IDAHO

Walla Walla, Wash. (*F*)	Maximum	54.2	63.5	71.3	77.8	88.2	86.7	75.5
	Minimum	36.8	42.6	48.6	53.7	60.8	60.2	52.3
	Mean	45.5	53.0	59.9	65.8	74.5	73.5	63.9
Moxie, near Yakima, Wash. (*F*)	Maximum	56.5	66.5	74.0	80.9	88.9	87.4	77.3
	Minimum	28.5	34.3	42.0	48.0	53.1	51.1	42.4
	Mean	42.6	50.4	58.2	64.6	71.3	69.5	59.9
Boise, Idaho (*G*)	Mean	44.2	50.1	57.6	66.0	72.8	71.8	61.9

PALOUSE REGION, WASHINGTON

Colfax, Wash. (*F*)	Maximum	50.8	60.0	67.9	73.9	82.8	82.8	72.2
	Minimum	30.0	35.1	40.5	44.6	47.4	46.5	40.4
	Mean	40.4	47.6	54.2	59.3	65.1	64.9	56.3

TABLE 1.—*Maximum, minimum, and mean temperatures, March to September, inclusive, for the principal plum and prune producing districts in the Pacific States*—Continued

SUMMARY OF AVERAGES BY DISTRICTS

	Mar.	Apr.	May	June	July	Aug.	Sept.
Maximum:							
San Francisco Bay and central California coast counties	° F. 64.6	° F. 70.3	° F. 73.5	° F. 79.2	° F. 83.2	° F. 81.9	° F. 81.2
Interior valleys of central California	64.9	71.8	77.8	86.6	94.4	93.0	85.8
Western Oregon and western Washington	55.7	61.8	67.0	72.5	80.1	80.3	73.0
Yakima and Walla Walla, Wash.	53.5	65.0	72.6	79.6	88.5	87.0	76.4
Minimum:							
San Francisco Bay and central California coast counties	41.7	43.2	45.7	48.8	51.1	50.5	48.8
Interior valleys of central California	42.0	45.2	49.5	54.6	58.8	57.9	53.6
Western Oregon and western Washington	37.7	40.2	45.2	47.1	53.0	52.6	48.2
Yakima and Walla Walla, Wash.	32.6	38.4	45.3	50.8	57.4	55.6	47.3
Mean:							
San Francisco Bay and central California coast counties	53.2	57.1	60.9	60.5	67.5	66.7	65.5
Interior valleys of central California	54.3	59.6	65.5	73.2	78.3	76.9	71.6
Western Oregon and western Washington	46.5	51.2	56.6	61.3	66.7	66.4	60.4
Yakima and Walla Walla, Wash., and Boise, Idaho	43.4	51.2	58.6	65.5	72.5	71.2	61.9

SITE AND LOCATION

In choosing a site and location for plum growing careful consideration should be given to spring frosts, soil drainage, transportation facilities, and also to irrigation in sections where it is necessary.

If spring frosts are common, rolling or sloping land should be chosen, avoiding the low, flat plains, depressions, and troughs of ravines through which the cold air, like water, flows to lower levels.

FIGURE 7.—Sites on a slope where soil and air drainage are better for orchards than in the lower portion of the valley in the distance, Emmett, Idaho.

Even differences of a few feet in elevation often prove of great importance in this respect (fig. 7).

The growth of plum trees on fertile soil washed down through ravines encourages the orchardist to continue plum planting there, but in such locations the planting of fruits which blossom later in the spring would usually result in less loss from frost and no doubt

prove more profitable. Orchards occupying the rolling areas bordering the larger fruit-growing valleys, while more difficult to cultivate, are decidedly more nearly free from frost injury to the blossoms than those on the low flat valleys or the high flat tablelands.

Where the soil near lakes of considerable size or ocean bays is suited to cultivation, only little, if any, loss from spring frosts need be feared. In the consideration of sites such places are preferable because the water will temper the hot days of summer as well as protect from the cold in spring. The effect of such a body of water is well illustrated near the border of Lake Vancouver, not far from the city of Vancouver, Wash., where prune production is an important industry and where it is claimed that severe injury to the crop by frosts is unknown. The opposite result in regard to frost naturally obtains along smaller rivers, as here the heavy cold air settles in and follows the course of the water.

FIGURE 8.—Prune trees, dead as a result of poor drainage—the fate of trees on low, heavy soil.

Soils which are low, heavy, and in danger of becoming waterlogged during wet seasons or in which surplus water from irrigation collects should also be avoided. While the plum is not so sensitive to an excess of soil water as some fruits, small crops and weak trees and often loss of trees follow planting in such places (fig. 8). Only well-drained soils should be selected.

The unquestionable advantage of facilities for irrigation in the regions where irrigation is practiced prove the need of choosing lands where a system is already established or where a water supply sufficient for the type of soil under consideration can be made available. Both prunes and plums are sold largely by their size, and as the soil moisture determines to a great extent the sizes of the fruit the water supply should not be overlooked.

The condition of country roads and the proximity of packing houses and shipping stations need also to be taken into account. While these are not so important where the fruit is to be dried, good smooth roads, preferably free from dust and with packing and shipping facilities close by, are decided advantages to the shipper of fresh plums who must send his product to distant markets.

VARIETIES

The ease with which new strains and varieties may be created by artificial crossing or by the selection of chance seedlings and the patience and intelligence exercised by many western plum growers in testing new types have led to the development of a large and ever-increasing number of varieties. Many of these varieties have been taken into almost every locality where orcharding is not entirely prohibited by natural conditions, and the requirements of varieties with respect to soil, weather peculiarities, and cultural conditions, both natural and artificial, have been determined perhaps more closely than for any other of our cultivated fruits.

Many of the commercial varieties of plums widely planted in the Pacific States were originated or first introduced into cultivation there, and in most instances in central California.

In establishing an orchard for the production of plums for the fresh-fruit market, it is the practice to plant a number of varieties which ripen in succession, so that the fruit pickers may go from one variety to another without interruption, thus avoiding the necessity of procuring additional help to harvest the varying number that ripen at the same time. Where there is a period of a few days between the ripening of varieties in the succession, or if a variety fails to fruit, considerable confusion and perhaps financial loss results from the disorganization of the picking, packing, and hauling crews. This emphasizes the importance of selecting varieties for their regular bearing habits as well as for quality and appearance of fruit and those so suited to the peculiar soil and climatic conditions that they fit into the successive ripening scheme.

Many varieties are partially or entirely self-sterile. When such varieties are planted, other sorts which will pollinize them must also be planted nearby. At the same time these pollinizers must possess desirable qualities for commercial planting and likewise fit into the list for successive ripening. With the great number of plum varieties, each with its peculiarities as to growth, production, quality of fruit, and the broad demands of the grower and the market, the choice for planting becomes one of greatest importance to growers. For prune making the conditions to be met are not so numerous as in the production of fruit for fresh shipment. The selection of a variety adapted to the natural local conditions, including soil and climate, is the principal problem. Shortage of labor and the loss of a little time in harvesting, processing, or delivering to local or distant markets cause no such loss or concern to the grower who dries his fruit as to the one who must harvest, pack, and deliver his fruit to the consumer within a relatively short time or else withstand a severe or perhaps total loss of his fruit by spoiling or having his product offered on a market when the price is unsatisfactory.

The expense of picking and packing the fruit, the purchase of shipping containers, and the cost of icing and transportation to the distant market is relatively considerably higher for the fresh fruit than for the dried product. Owing to these expenses the hazards in the production of fresh fruit are considered by many to be greater

than for prunes, although the high market price for fresh fruit makes its culture desirable if natural conditions are favorable to the development of large fruit of good quality. A large number of varieties are under cultivation for the production of both fresh and dried fruit, although the diversity required for the profitable growing of fresh shipping plums has led to the planting of a much greater number of varieties for this purpose than for prune production.

The dates of blooming as well as of ripening of a variety may vary from a few days to 3 or 4 weeks from year to year with the different varieties, depending on climatic conditions. Slight fluctuations sometimes occur in the relative ripening dates of varieties, although within a given orchard these differences are small. At different elevations and under other varying conditions both blossoming and ripening dates of a variety may differ considerably even in adjoining orchards. The conditions that prevail in low, wet, heavy lands and at high elevations tend to cause late blossoming and ripening of the fruit, while those that characterize the well-drained soils of low, rolling land, especially those of southern and eastern exposure, favor relatively early blossoming and ripening.

Considering the principal plum sections in California, in which are grown more or less extensively nearly all varieties of plums produced commercially in the Pacific States except the Italian Prune, harvesting starts during the latter part of May in the lower San Joaquin Valley and about a week later in the foothill section near Vacaville, in Solano County. In the Vaca Valley, which borders these foothills, the earliest harvests are about 1 week later and almost simultaneous with the foothill section of Placer County and a few days in advance of the main portion of the Sacramento and San Joaquin Valleys.

The principal variety grown for fresh shipment in the other States included in this discussion—Oregon, Washington, and Idaho—is the Italian Prune. Other varieties grown commercially in these States include Tragedy and Pond, with less important plantings of California Blue, Standard, and a few others. The ripening dates of these varieties in the Pacific Northwest are 3 or 4 weeks later than in the plum-producing sections of California. Only a few varieties are favored for planting in the Pacific Coast States at the present time, although large fruit shipments are made from many other varieties that were planted in recent years.

A few important qualities of the most prominent commercial varieties growing on the Pacific coast at the present time are here described to guide the orchardist in his choice for future planting. These varieties represent three groups or classes of plums: (1) The Japanese sorts, those derived from the oriental form known to botanists as *Prunus salicina*, including many varieties grown for their fresh fruit; (2) those derived from the European form (*P. domestica*), which includes the so-called European, domestica, purple, or blue plums and to which belong the varieties grown for prunes as well as many for shipping fresh; (3) hybrid sorts originated by crossing Japanese with native plums, grown for use in the fresh state.

VARIETIES OF PLUMS AND PRUNES IN THE PACIFIC STATES

VARIETIES OF THE PRUNUS SALICINA (TRIFLORA) GROUP AND ITS DERIVATIVES OR HYBRIDS

Beauty.—This is the earliest ripening of the commercially grown varieties and is therefore a favorite in sections where fruit is produced for the early market. Cross-pollination is not essential. The tree is thrifty and inclined to bear well and regularly; thinning the fruit is found necessary almost every year. The fruit is medium in size, often with considerable variation on the same tree. It is very attractive and carries to the market fairly well. This is the most popular early ripening variety at present.

Burbank.—This is one of the principal varieties of the Japanese group grown on the Pacific coast. Its harvest comes after the Climax and Maynard and just before the Santa Rosa. The fruit is medium in size and quality and carries to market exceedingly well. The Burbank is a regular and prolific bearer, and unless thinned the fruit is often undersized. The blossoms are self-sterile, but appear with those of many other varieties which, if near by, are usually sufficient to pollinize it. The ripening season is rather long. The tree is thrifty, spreading in habit of growth, and suited to a wide range of climatic conditions. This variety is planted for its regular and heavy crop of fruit, but it ripens in the middle of the plum-shipping season, and low prices are sometimes received for it.

Climax.—Fruit large and attractive, but ripens rapidly, is rather soft when ripe, and therefore requires considerable care in harvesting and must be hurried to market. The blossoms are self-fertile, and regular crops of fruit are therefore expected.

Duarte.—Fruit very large, of good shipping quality, and has attractive dark-red flesh. This is the earliest to ripen of the so-called "blood" plums, but one of the latest of the Japanese type of varieties grown for fresh-fruit shipment. Its blossoms are self-sterile, but appear late, and good crops are expected where the trees are planted near other varieties of the same group.

Formosa.—While among the earliest ripening varieties, its fruit is very large. It is one of the most attractive of commercial plums, of excellent eating quality, and carries to distant markets exceedingly well. The blossoms open early in the spring and therefore are in danger of being injured by frosts and are self-sterile. The tree is thrifty and grows to a large size, but is inclined to come into bearing late. As a result, many orchards of it have been top-grafted to other varieties and its planting has been nearly discontinued. Good crops have been harvested where trees are growing near the Wickson, the Santa Rosa, and some other varieties of the Japanese type and when there is an abundance of bees. The yield of this variety is usually the best when it is top-grafted on old trees.

Gaviota.—Fruit very large, attractive, of good eating quality, fair in texture, and keeps and ships exceedingly well. The blossoms appear rather late, and the fruit ripens among the latest of the varieties of this type and a little after midseason for fresh-plum shipments. On account of its firm flesh the fruit may be harvested over a long season and if picked when well ripened will still reach the market in good condition. The trees are vigorous, prolific, and inclined to be regular in bearing if the blossoms are pollinized. Its blossoms are self-sterile, and the trees should therefore be planted near other varieties of the same group which blossom at the same time. This variety is still popular for planting.

Kelsey.—Fruit large, of good eating quality, attractive when well colored, keeps and ships well, has a rather long ripening season, and is one of the latest of the more extensively grown Japanese varieties. The fruit colors well in sections where cool summer breezes prevail and in foothill sections, but poorly in the hot floor of the interior valleys of California where fruit for fresh shipment is grown extensively. Its blossoms are self-sterile, but it usually bears well when planted with closely related varieties. In sections where the fruit colors well this variety is now popular for planting.

Santa Rosa.—This variety is harvested somewhat before midseason, and the ripening season is longer than for many varieties of Japanese plums. The fruit is large and very attractive, purplish crimson in color, having dark-red flesh of fine eating quality, and carries well to market. It blooms early, and the blossoms are sometimes injured by frost. It is benefited by cross-pollination and on account of late frosts and faulty pollination is inclined to be

irregular in bearing. The Wickson and Beauty varieties, blossoming about the same time as the Santa Rosa, have been recommended for planting near it for pollinizers. The tree is a vigorous, compact, upright grower and should be pruned to induce a moderate new growth and an open framework. Severe cutting back of the tops causes a long, erect growth of new wood which forms a compact top, thus heavily shading the branches and spurs of the old wood. This is now a favorite among Japanese plums for planting.

Satsuma.—Fruit of good size, dull red in color, and purplish red flesh. It is of good flavor, high in dessert quality, and favored for culinary purposes but not for shipping fresh, although a small acreage is grown for this purpose. The tree is vigorous, but inclined to bear light crops until it reaches several years of age.

Wickson.—Fruit very large, attractive, good in flavor and dessert quality, and carries to market well. It is one of the earliest varieties to blossom in the spring, and late frosts often shorten the crop. It requires cross-pollination. As it blossoms with but few other varieties, light crops sometimes result from lack of other pollen. It is planted more extensively along the Pacific coast, probably, than any other variety of the Japanese group.

VARIETIES OF THE PRUNUS DOMESTICA GROUP

Agen (*French prune or Petite prune*).—The fruit of this variety is perhaps the smallest of any of those used for prunes. It is dull reddish purple in color, and very rich and sweet in flavor, and has a rather tough skin. As the sugar content is high, it dries quickly and easily. The tree is thrifty, a moderately vigorous grower, and regular and prolific in its bearing habits. It blossoms in midseason for the prune varieties and ripens its fruit late. The fruit clings to the tree until after drying starts, which insures against injuries during harvest, thereby shortening the period which would otherwise be required for it on the drying trays. The planting of this variety exceeds by many times the combined area of all other varieties grown for prunes in California, and it is of commercial importance in western Oregon and western Washington. Its blossoms are self-fertile, and it may therefore be planted in solid blocks, although interplanting with the Sugar and Imperial Epineuse varieties has been recommended as a benefit to fruit setting. It requires a deep fertile soil for the production of good crops of large fruit. Adverse local conditions or overheavy crops result in small fruit. An abundant supply of small fruit, with prices on a size basis, is the chief hindrance to a satisfactory market price for this variety.

California Blue.—Called Vacaville in some sections. Fruit ripens in midseason, is medium to large in size, round, bluish in color, of only fair dessert quality and flavor. Its ripening period is rather short. The tree is very prolific, but it bears only in alternate years, at least in some localities. Its blossoms are self-fertile. The tree is inclined to branch but little, is spreading and open in habit, and produces fruit on wood of all ages, making the harvest easy. As yet its culture has been confined mostly to a few sections in central California near which it was originated, although it is giving encouraging results in central Washington orchards. It is not favored for planting at present.

Clyman.—Ripens earliest among the domestica group of plums on the Pacific coast and follows closely the earliest of the Japanese group. It is dark blue in color, of medium size, only fair in eating quality, and carries only fairly well in shipment. The blossoms are self-sterile, open early, and the trees should therefore be interplanted with other early blossoming varieties. The Tragedy variety has been suggested as a pollinizer. Clyman is not a dependable producer in most sections, probably on account of lack of pollination and injury by frost. The tree is a vigorous grower and favored as a stock for top grafting, but is no longer planted for fruit production.

Diamond.—Fruit large, handsome, rather sour, and second rate in eating quality, but its tartness has made it a favorite during late years in eastern markets. It is firm in texture and carries well to distant markets. Its fruit ripens a little after midseason and is the first purple plum of commercial importance to ripen after Tragedy. The wood of this variety makes probably the poorest union with the peach stock of any of our commonly cultivated plum varieties.

Giant.—Fruit medium to large in size, attractive in appearance, but lacking in flavor and juiciness. Owing to its rather dry flesh it carries to market exceedingly well. Its blossoming season is late, and the fruit ripens among the

late varieties commonly grown for their fresh fruit. The fruit is about midway in size between that of its parents, the Agen and Pond. Like the former the tree is vigorous, its blossoms are self-fertile, and it fruits heavily from year to year. It resembles the Pond in that the fruit is somewhat lacking in flavor and juiciness and is rather coarse. It is not popular for planting at present.

Grand Duke.—A plum which has been widely tested in plum-growing centers of the Pacific States and is extensively planted in California. Its fruit is large, firm, not very juicy, has a high sugar content, keeps and ships well, but is second rate in dessert quality. The blossoms appear late and require cross-pollination. The fruit ripens late and the ripening season extends over a comparatively long period.

Imperial Epineuse.—Fruit large when compared with that of other varieties grown for shipping fresh and larger when dried than that of other varieties commonly used for prune making. It is dark red, juicy, of good quality and appearance, and excellent in eating quality. Owing to the high prices paid for the dried fruit, the larger portion of the crop of this variety is made into prunes. The tree is vigorous, but inclined to be a shy bearer in most localities, this being due, probably, to the lack of cross-pollination. The Agen and Sugar varieties have been recommended for interplanting with the Imperial Epineuse as pollinizers. The tree requires a deep, fertile soil for satisfactory growth. This requirement, together with its irregular cropping tendencies, has prevented it from being extensively planted in some plum centers. It is at present grown to a considerable extent in many places, and in the Sonoma Valley is one of the most favored varieties.

Italian Prune.—Fruit medium to large, dark purple in color, of a pleasing tart flavor, and firm in texture, making it first class both for fresh shipment and for drying. It is also used largely for canning. It is grown extensively for these purposes in Oregon, Washington, and Idaho, where it is by far the most important variety under cultivation and one which is still the most extensively planted. The blossoms are self-fertile, and therefore it may be planted in large blocks without other varieties. It is adapted to a wide range of temperature, but requires a deep, fertile soil.

Jefferson.—Fruit similar to Golden Drop and used for canning, as is that variety; it is one of the most popular varieties for that purpose. Although a fruit of good eating quality and flavor it is not favored for fresh shipment on account of its color. Owing to the very restricted demand for plums for canning, the demand for trees of this variety for planting has nearly ceased.

President.—Fruit large in size, very dark purple in color, of fair eating quality and texture, ripens among the latest of the purple domestica plums, and carries to the market well. The tree is thrifty and inclined to bear regular and heavy crops. It is recommended for planting by those who wish to grow late-ripening plums for the fresh market.

Pond.—Called "Hungarian prune" on the Pacific coast. Its fruit is large for the commercially cultivated varieties of this group, very attractive, and purplish red in color. Its flesh is firm and lacking in juiciness, making it well suited for shipping. In eating quality it is only second or third rate. There is a tendency for the fruit to form doubles, one side often being imperfect in shape. Such fruits are not favored in the markets and are difficult to pack. Its blossoming season is intermediate with other plums and its fruit-ripening season is late. The branches make a slender upright growth and are inclined to send out too few fruiting twigs and branches. The tree should be pruned to induce a moderate wood growth and branching. In the interior valleys of California, where the summers are hot, the tree is lacking in vigor. There is often a poor wood and leaf growth and considerable sunburning of wood and fruit. In States farther north, where the summer temperatures are lower, the tree is thrifty and productive, with decidedly less injury from sunburning.

Reine Claude.—Considered one of the best varieties for canning, but on account of the small size of the fruit and the light demand for plums for canning, its planting has been almost discontinued.

Sergeant (*Robe de Sergeant*).—Fruit somewhat below the medium size of varieties of this group grown for their fresh fruit. When dried it is about medium size among the prunes. Its dark-purple color, becoming almost black when the fruit is ripe, and its rich pleasant subacid flavor make it well suited for prunes. The tree is thrifty but often fails to bear satisfactory crops, especially in the cooler sections. It is considered profitable only on deep fertile soil, as elsewhere the fruit is too small. This variety has been grown to a

considerable extent in California, although new plantings of it are rare both there and in the States farther north.

Sugar.—Fruit medium in size when compared with other varieties grown for fresh shipment, although considerably larger than its parent, the Agen. It is dark purplish red in color, juicy, and has a rather tender skin. It is sweet, but otherwise second rate in dessert quality. The blossoms appear late, making them comparatively free from danger of frost injury. Being also self-fertile, good crops are usually insured. The trees of this variety are inclined to be prolific. If the fruit is not thinned, small sizes usually result, and an excessive crop is often followed by a light one or a failure the following year. The tree is open and spreading and the wood very brittle and inclined to become stunted where little pruning is done. Good soil and cultural conditions are required for a satisfactory tree growth. When the market price for plums is low, the fruit is dried into prunes, although considered only second class for this purpose. While less popular at present than in past years, it is still found in practically all centers of plum production in the Pacific States.

Tragedy.—One of the earliest and best as to eating quality of the domestica plums that are grown for fresh shipment and for profitable returns. It is grown in most sections of central California from which fresh plums are shipped, and to some extent in central Washington. Its fruit is medium in size for a domestica, attractive in appearance, and ships well. The blossoms are self-sterile, and poor crops often result from this cause. The Clyman has been recommended as a pollinizer.

Yellow Egg.—Fruit large, only fair in eating quality, and rather soft when ripe, making it inferior in this respect for fresh shipment. Its golden yellow color makes it suitable for canning, but not for selling fresh. For canning it is one of the most favored varieties, but the decreased demand for plums for canning has resulted in the top-grafting of some orchards of this to other varieties. The trees are vigorous and inclined to bear regular and heavy crops.

POLLINATION

Among the foremost of the considerations to be given to the planting of plum orchards is that of pollination. This is more especially true with varieties for fresh-fruit shipment, for many common varieties grown for this purpose are entirely sterile with their own pollen, or the crop may be greatly increased by cross-pollination. To the lack of pollination many light crops or entire failure may be attributed. In some instances the planting of a variety has been discontinued on account of poor crops from this cause.

The most practical means for providing cross-pollination in commercial orchards is to interplant varieties which may be fitted into the scheme of a ripening succession to extend the fruit harvest. In the interplanting of varieties it may be convenient to plant the succession so as to accommodate fruit-picking crews, but this should be done in every case to favor pollination. Only a few rows of a variety known to be entirely or to a large degree self-sterile should be planted together. Solid blocks of these varieties should never be planted, as with self-sterile varieties. For convenience in fruit harvesting, from two to four rows of a variety are usually planted together.

In the selection of a pollinizer, provided more than one variety will cross readily with the one to be pollinized, a variety which blossoms with it, having a long blossoming period and regular in blooming habits, should be chosen rather than one which tends to blossom in alternate years.

As a group the Japanese varieties and those derived from them are considered to require cross-pollination or to be greatly benefited by it with the exception of the Climax, which is self-fertile. Among the domestica varieties (the only other group represented in com-

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mercial plum planting in the Pacific States), the Tragedy is self-sterile, as are also the Imperial Epineuse and other less important varieties. Several of them, including two important varieties for prune production—the Agen and Italian Prune—are self-fertile.

While varietal tendencies regarding pollination are very decided, the percentage of blossoms to set fruit, irrespective of weather conditions, varies with the age and thrift of the tree. Where top-grafted on older trees, especially if the stock and scion are somewhat uncongenial and produce an imperfect union, a heavier set of fruit sometimes results than from normal trees. Heavy crops under these conditions have been noted in the case of the Formosa variety. This is a self-sterile sort and notorious for coming into bearing late. Eight-year-old grafts of the Formosa in old apricot trees adjoining Santa Rosa trees have been observed to bear excellent crops, while 8-year-old Formosa trees started in a nursery and planted the same distance from the Santa Rosa trees as were those produced by top-working bore practically no fruit.

FIGURE 9.—Bee stands in a plum orchard. Cross-pollination in plum and prune orchards by bees has been proved of so much importance that many of the growers in California place stands in their orchards, at least during the blossoming period.

The presence of bees in the plum orchard at blossoming time has been demonstrated to be almost an economic necessity (fig. 9). Poor crops or perhaps failures may be expected of self-sterile varieties where no bees are present, and even with self-fertile varieties the presence of bees has caused a decided increase in the crop.

Cold, foggy, or rainy weather at blossoming time is very detrimental to the setting of fruit. A careful selection of varieties must be made for planting in places where such weather is common during the spring, and commercial plantings should be confined to varieties that have proved themselves suitable to the local conditions.

STOCKS USED IN PROPAGATING PLUM TREES

Only a small portion of the plum trees for commercial planting are propagated in the home nursery, professional nurserymen being

depended on to supply trees with stocks suited to the orchard conditions. In his selection of stocks the nurseryman is guided by the demand of orchardists for trees propagated on one stock or another and by his own interest in producing cheaply propagated trees which make a rapid growth.

For propagating plum trees the myrobalan plum and the peach are by far the most important, although the almond is used in some localities, at least in California. An occasional orchard may also be found where the Marianna plum and the apricot are used for stocks. Each of the first three stocks mentioned is suited to different soil conditions, and the myrobalan plum and the peach are suited to the soils generally chosen for plum planting. The myrobalan plum is preferred for deep, heavy fertile soils, especially if the rainfall is heavy or the orchard is under irrigation. It is not a rampant grower, but is a vigorous, long-lived, hardy, and deep-rooted tree, the roots withstanding a higher soil-moisture content than other kinds of roots. The myrobalan plum, however, prefers a deep, fertile, heavy, well-drained loam and is therefore at home in soils favored for prune production and is in most general use in that industry. It is also the one most commonly used for planting in the deep, fertile bottom lands, where plums are grown for the fresh-fruit market and for canning.

The peach root, while less resistant to excessive soil moisture than the myrobalan plum, will thrive better than the latter or other stocks mentioned in poor, shallow, or light soils, because its roots do not go so deeply into the earth, but make a vigorous spreading growth. A good moisture content and a soil of good tilth are, of course, required for the best root growth of the peach. It starts growth early in the spring, grows rapidly, succeeds in a wide range of soils, and is generally considered the most satisfactory stock for early ripening plum varieties, at least in the shallower soils, where these varieties are extensively grown. It is used to a considerable extent for varieties for prune making where the soil is not sufficiently deep or the moisture content is below that required for the best development of the myrobalan roots.

The almond, one of the stocks used in California, is a thrifty long-lived tree, growing best in deep fertile well-drained soil and is the most drought resistant of the stocks commonly used. It does not withstand excessive soil moisture as well as the peach or the myrobalan plum, but succeeds in places where it is too dry for those stocks. The plum tree is generally considered to grow less rapidly on the almond root than on the others commonly used and is propagated less extensively on it than on the others. The almond is used to some extent as a stock for prunes in deep fertile soils not under irrigation. Large old prune trees which have excellent records of fruit production are found growing on this stock.

The Marianna plum is employed as a stock for plums in California, but it is more sensitive to drought and to excessive soil moisture than the other stocks, suckers badly, and is generally little used. It grows quickly and well from cuttings, which insures cheap and uniform stocks.

In the Northwestern States the myrobalan plum has been used almost exclusively as a stock since plum growing became an impor-

tant industry there; but in California, where fruit growing is a more diversified industry and the growing of plums for fresh shipment is a comparatively new enterprise and the demand for different fruits has fluctuated considerably, the stock which is at present considered best for planting under a given condition is not the one found in the orchard in a great number of instances. Much superficial testing of different stocks has been in progress, and the changing popularity of varieties has caused many orchards to be top-grafted to other fruits or varieties, although the tree which then becomes the stock is not in all cases the one on which the new variety should be grown.

TOP WORKING

The principal reasons for top working in the commercial orchard are the changing demands of the market in regard to the variety

FIGURE 10.—Old apricot trees top-grafted to plums. The trees on the left have just been grafted; the scions will start into growth as the trees renew their activities in the spring. On the trees at the right the grafting was done 5 years before. Vacaville, Calif.

and quality of fruit and the desire to bring the trees quickly into production (fig. 10). As there has been an ever-changing demand in plum varieties, especially those for fresh-fruit shipment, much top working of trees has been done in sections of central California where the growing of plums for fresh shipment is an important industry. In these sections top grafting has been practiced since commercial plum growing was first established, and it is still a common procedure. It has proved to be a satisfactory method for changing the production of an orchard from one variety of plums to another, for the replacing of certain other fruits with plums, and for testing new varieties by bringing them quickly into bearing (fig. 11). Only a few years are required for the new top to come to commercial production where conditions for fruit growing are good and where varieties inclined to be prolific are used. A crop of one to two crates of plums per tree has been harvested the second season after top grafting, thus causing an interruption of only 1 year without

a marketable crop in changing trees from one variety to another. This, however, is a more rapid change than would usually be expected. The top grafting of peach trees to plums was practiced to a large extent in this region a few years ago, owing to the greater popularity of the plum than the peach.

The operation of top grafting is easily performed, and success may be expected if the trees selected are vigorous. The work of top grafting is usually done in winter and spring after the pruning has been finished. In performing this work only strong, well-spaced, and well-shaped branches should be selected. These should be carefully sawed off at the desired height and the scions inserted by either the cleft or bark-grafting method. As large wounds heal slowly, making the entrance of wood-rot fungi probable, small branches are preferred to large ones. If a limb 2½ or 3 inches in diameter or a little larger must be selected, at least three scions should be inserted, while for the smaller branches two are sufficient.

FIGURE 11.—An orchard of top-grafted plum trees at Vacaville, Calif. These trees were originally the Kelsey plum. They were top-grafted 8 years before to the Beauty plum.

Instead of top working by grafting, budding into small branches which grow from cut-back limbs is sometimes practiced for changing the tree from one fruit to another.

In top grafting, the unfortunate use of scions of varieties which do not form strong unions with the stock has resulted in the loss or poor growth of many trees. While the varieties of Japanese plums most commonly grown are inclined to be congenial with the peach stock, a number of varieties of the domestica group are not (fig. 12). The Diamond, Grand Duke, and California Blue varieties when grafted on peach make perhaps the poorest unions among the varieties of this group in the region under observation, although the tree may continue to bear profitable crops over a considerable term of years after grafting. When a variety is top grafted to an uncongenial stock it will often appear undernourished, owing to the inability of the plant food to pass readily into the tissue below the

FIGURE 12.—Poor graft unions resulting from top-worked old peach trees with the Grand Duke plum. The plum grafts are 12 years old. Note the enlargement of the lower portions of the grafts and injury from sunburn below. Vacaville, Calif.

FIGURE 13.—A poor union of the Grand Duke plum on a peach tree, resulting in poor growth, sunburning of the limbs, and subsequent decay and weakening of the branches. Such branches are easily broken by winds.

graft union. The poor growth of foliage resulting from this condition causes poor protection from the sun; the old branches of the stock sunburn easily and are therefore more easily broken by the wind than where good unions are formed with the scion (figs. 13 and 14).

The plum on the apricot or almond sometimes gives unsatisfactory results in top grafting, while good unions are expected in grafting one variety of domestica plum with another, and in grafting Japanese varieties on domestica varieties. Trees known to form poor unions with the variety the orchardist wishes to grow are sometimes top-grafted with a variety known to unite well with both, and the next year these grafts are worked to the variety chosen for fruit production (figs. 15 and 16). "Double working," as this practice is commonly termed, may be used in some instances to decided advantage if the trees to be top grafted are large and well-shaped.

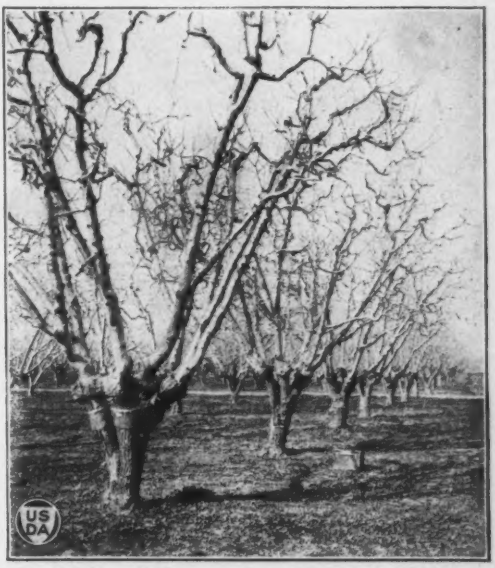

FIGURE 14.—A row of peach trees which were top-worked to the Diamond plum. The enlargements at the points of union between the peach and plum wood indicate a lack of congeniality, although a fairly strong growth has been made by the plum top. The plum tops are about 20 years old.

To secure an open growth for a variety naturally compact and upright growing, the variety is top-grafted on one that is naturally open and spreading. This is done after the spreading tree is 2 or 3 years old and has its framework branches established (fig. 17).

That there is some obscure factor involved in the congeniality of stock and scion is suggested in figures 18 and 19, which show the Agen (*French prune*) top-worked on almond trees. In one case faulty unions have developed; in the other, congeniality appears to exist. Other similar instances are matters of observation.

Prior to actual trial there is apparently no means of determining what plum or prune varieties will show congeniality with particular stocks. For example, the Agen has given excellent results when top-worked on apricot, though the plum wood at the point of union may grow somewhat larger than the apricot wood. The Agen propagated in the nursery on almond stocks sometimes makes a good growth, and the trees are long lived and vigorous. On the other hand, in the case of the Imperial Epineuse plum, after

growing for nearly 25 years the limbs top-grafted on a myrobalan plum tree began to indicate weakness at the point of union.

FIGURE 15.—Top of a seedling plum tree (in the foreground) 2 years after being double-worked on apricot. A short section of Pond (*Hungarian prune*) is between the base of the plum limbs and the apricot. The tree therefore shows an apricot base top-worked to the prune, which in turn was grafted over to a seedling variety of plum.

It does not necessarily follow that a variety propagated in the nursery on a particular stock and grown successfully in the orchard

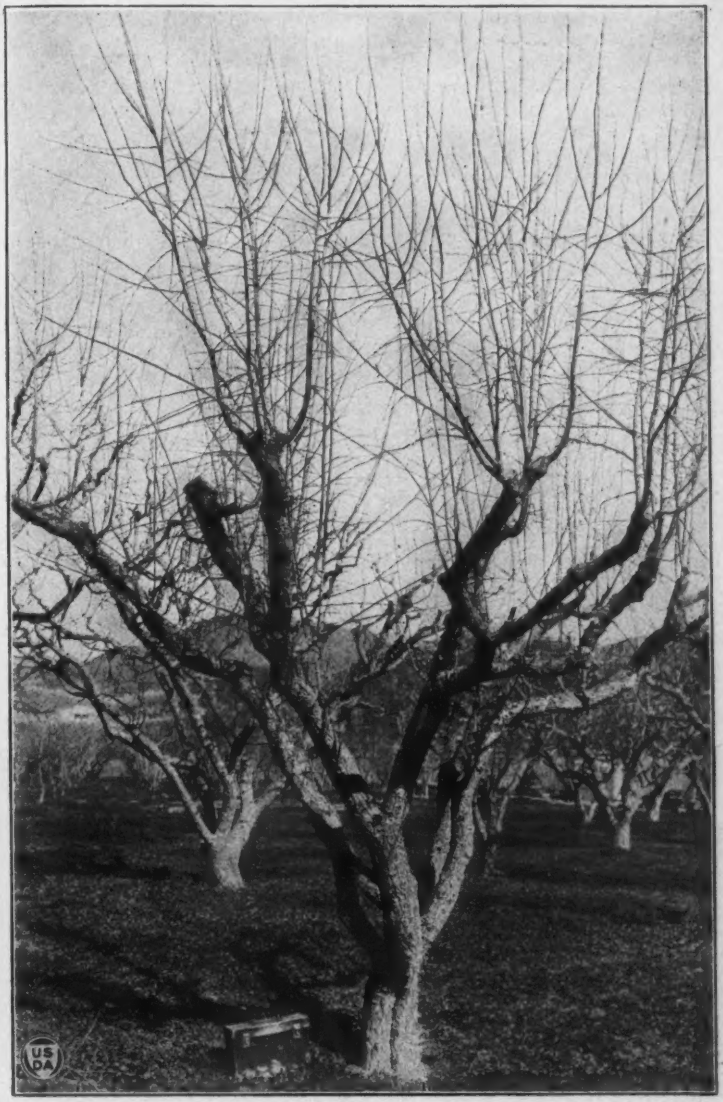

FIGURE 16.—Scions of the seedling plum referred to in figure 15 grafted directly into apricot limbs. The growth of the plum branches, where double-worked with sections of Pond (*Hungarian prune*) wood between the plum and the apricot, is appreciably more vigorous than in the present case. This obviously suggests, although it does not prove, that double-working in this combination is advantageous.

will give the same successful results if top-worked into a mature tree of the same species as the seedling nursery stock.

The work of top grafting is not difficult or complicated. With moderate skill and a little practice one may expect a large percentage of his scions to grow. As the new top grows, all rough portions of the stubs in which the scions were placed should be carefully removed

FIGURE 17.—The Formosa plum, an upright-growing variety, top-grafted on a 5-year-old peach tree to make an open top. Vacaville, Calif.

with a saw and chisel to insure the healing of the stump as quickly as possible. Where tree tops are removed for grafting, the stumps not needed should be carefully removed and the others protected from the sun with whitewash, especially if the trees are young and their branches are not protected by thick bark. The growth of young branches to furnish shade should be encouraged also. Carelessness in grafting and neglect of the old stumps and branches

FIGURE 18.—An Agen (*French prune*) tree top-grafted on an almond stock. The union between the almond and the prune wood is poor, and the growth of the prune top is unsatisfactory. Sprouts have been allowed to grow on the almond portion of the tree for the purpose of nourishing the roots. In some instances this practice has resulted in a marked improvement in the general condition of the tree. It would appear that in this case almond roots can maintain the Agen prune top, but that the food material elaborated by the latter does not adequately maintain the almond roots.

in succeeding years, both through failure to remove dead stumps of branches or portions of them which the new scion cannot over-

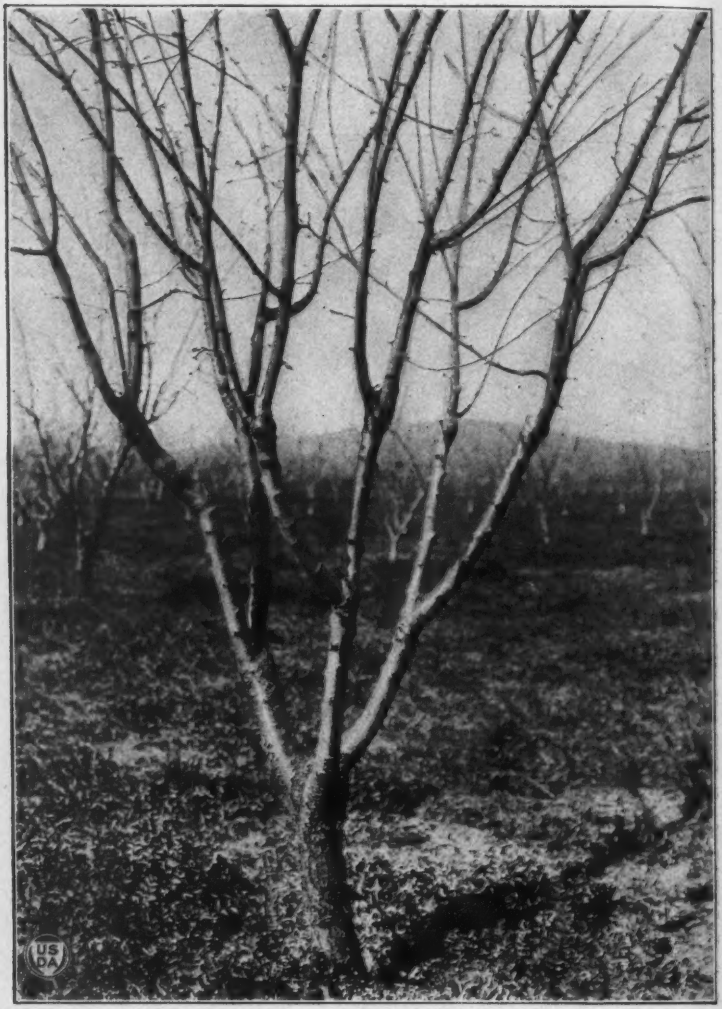

FIGURE 19.—An almond tree the main limbs of which, like the one shown in figure 20, have been top-grafted to the Agen (*French prune*). This tree stands next in the row to the one shown in figure 20, but the congeniality between the almond and the prune appears to be satisfactory, and the tree is thrifty. A varietal strain or other obscure factor may explain the difference in the congeniality in these two instances.

grow, has often resulted in sunscald, followed by the entrance of wood-decaying organisms and the ultimate loss of the tree. Such

losses usually follow several years of unsatisfactory crops of fruit, and are by far the most severe on top-grafted trees where stock and scion are somewhat lacking in affinity (fig. 20). Wood-decaying organisms, entering through grafting wounds or sunburn following grafting, are a very common cause of loss of top-grafted trees and necessitate the removal of a large number of trees annually. Often the removal of the entire orchard is necessary, owing to the poor stand of thrifty trees remaining after the removal of dead or unprofitable ones.

FIGURE 20.—Sunscald and decay in a peach stock which resulted from top-grafting with an uncongenial variety of plum, followed by neglect in caring for the stumps of branches removed in top-working.

DISTANCE FOR PLANTING

From 18 to 24 feet has been the range commonly used for spacing plum trees in the orchard, 20 feet each way being the most common distance. Where soils are fertile but the trees of the varieties planted are naturally small or upright in habit of growth or conditions are not generally suited to the production of large trees, the shorter distances are usually preferred. They are also sometimes preferred where a method of pruning is used to maintain low compact heads, provided water for irrigation is available, so that the trees cannot rob each other of their needed moisture supply. For trees naturally thrifty and planted for a permanent orchard, 20 feet each way is generally considered the best distance. In fertile, well-watered soils 26 to 28 feet each way is believed best for naturally large growing prune trees.

Planting too close has been the cause of many light fruit crops, of alternate bearing of trees, and of the generally poor production which is common in some districts. If close planting is practiced where the soil is of only average depth and quality, or where irrigation is lacking, or where culture is in part neglected, only irregular crops and slow, weak growth may be expected after the trees are a few years old and the roots have occupied all the land. Where ideal cultural conditions prevail, with a pruning program suited to the

variety and conditions, fair yields may be expected even with close planting (fig. 21).

NURSERY TREES FOR PLANTING

One-year-old trees of average size are considered most suitable for orchard planting. All trees should be propagated on the kind of stock best adapted to the land to be planted, and all should be free from injurious insects and plant diseases. Provided the interstate and intercounty quarantine regulations have been properly carried

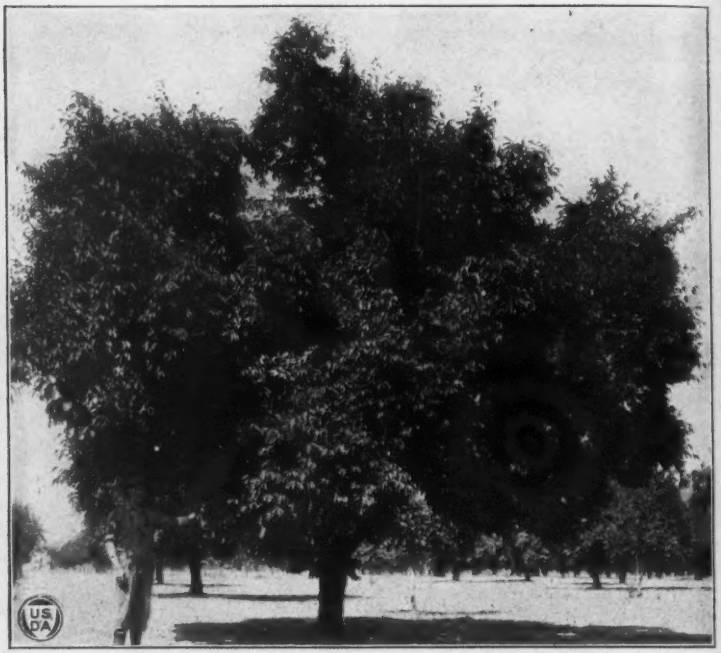

FIGURE 21.—A 30-year-old Italian Prune tree which is prolific and bears regularly while standing where it is not crowded. Under similar soil conditions in a nearby orchard, but with the trees planted 18 by 18 feet, the growth of the trees is poor and the production irregular. Douglas County, Oreg.

out, there will be but little risk in regard to insects and diseases when buying a nursery tree, and the purchaser should make sure that all provisions of the law pertaining to the sale of nursery trees in his locality are strictly adhered to. Nursery trees with a well-developed system of thrifty roots and of average size rather than very small or extra large should be chosen.

TIME FOR PLANTING

Like other deciduous fruits, plum trees should be planted sufficiently late in the fall so that new wood will not start growth until

the following spring, or they may be planted in the spring while the soil is still cool and before the time for wood growth to start. The trees should never be planted until the soil has been well prepared and is sufficiently moist to prevent the roots from becoming dry. In California, western Oregon, and western Washington, where the winter temperatures are mild, plantings may be made at any time during the winter and even until after March 1, with little fear of injury to the trees.

Loss of trees from carelessness is a common occurrence in newly planted orchards. Where planting is for any reason delayed after the trees are received from the nursery they should be heeled in carefully in a light, moist soil until ready for planting. Care must be taken to protect the trees from the sun and drying winds while handling, for neglect at any time from the time they are dug in the nursery until they are planted in the orchard may result in loss or delay in growth.

ORCHARD CULTURE

The cultural operations as practiced in most commercial plum-growing centers of the Pacific States are a combination of cultivation, irrigation, and the growing of cover crops. Where water for irrigation is available these operations are closely related, and the performance of one is often dependent on the other. In nonirrigated sections cover crops must be handled at the convenience of cultivation. As most of the annual rainfall in the plum-growing centers of these States is confined to the fall, winter, and spring seasons, occurring mostly while the trees are dormant, and as the summers are hot and dry, cultivation to destroy vegetation and thereby prevent the loss of moisture through it is important if irrigation is not practiced. Under these conditions it is the custom to plow to a moderate depth as early in the spring as the soil becomes sufficiently dry to work well, following the plow with some tillage implement designed to smooth and loosen the surface.

Too much care cannot be given to the choice of the time for this spring plowing. If the soil is worked while too wet, so that it is compacted, as in the case where the surface of the furrow is left shining when it is turned by the plow, the soil will dry out hard and remain so for some time. In this condition disintegration in this compact soil is delayed, with the result that the development of the food supply for coming years will be retarded. Adobe soils, which in some localities are planted to plums, must be plowed when wet, but such soils crumble or slake to some extent upon drying and may then be worked to the desired texture. On the other hand, if the soil is too dry when first plowed, the operation will be difficult and usually poorly done. The soil will turn up cloddy, and only an ineffective soil mulch will be formed, permitting further drying of the subsoil. When the moist soil crumbles into small particles upon leaving the plow, covering well all vegetation, subsequent tillage is more effective and conditions for the fruitfulness of the trees much better than if the land is plowed when either too wet or too dry. Deep spring plowing which will prune the new root growth should be avoided, especially after the fruit has set. During the remainder of the summer, shallow-going tillage implements should be used at intervals to destroy vegetation and so conserve soil moisture.

It is claimed by both growers and buyers that plums from soils that are nonirrigated but well-cultivated are better in eating quality, carry better when shipped fresh, and dry into heavier prunes than those grown on land where frequent and abundant irrigations are given.

The number of cultivations required under the local climatic and soil conditions must be determined by the orchardist, who must fulfill but not exceed the demands of economy in his orchard-cultivation expenses.

To eradicate noxious weeds, of which the grasses and the morning-glory are the most troublesome, frequent plowing, rather than the use of shallow-going implements for stirring the surface soil, is necessary.

Where cover crops are grown in nonirrigated sections care must be taken that the plowing is done when the soil is in the proper condition. Spring plowing is sometimes delayed to permit a heavier growth of the cover crop, but with doubtful benefit in nonirrigated sections, since in such sections soil moisture is the principal limiting factor to successful plum production. Cover crops are highly desirable if their growth is made during the late summer and fall, but not if they are grown in the spring at the expense of moisture which should be retained for the trees. If the plowing is done so late that the cover crop does not decay promptly a free passage for air will be provided and the subsoil immediately below will dry out rapidly.

Systems of tillage and cover cropping differ considerably in irrigated and nonirrigated sections. Under irrigation the soil moisture taken by the cover crops may be replenished and cover crops managed more at the pleasure of the orchardist. The soil may be prepared at any time for seeding these crops and moisture for their germination and growth provided by irrigation. If, owing to miscalculation in the spring, the soil becomes too dry to plow well, water may be applied, although it is considered better to plow when the soil first reaches the proper condition than to allow it to become dry. It is a common practice after this plowing to go over the orchard once or twice with a disk or drag harrow, giving no further cultivation except the necessary furrowing for irrigation until the time for seeding a fall cover crop. Where water is scarce or expensive, irrigation is delayed as long as possible in the spring, and unless the orchard has a permanent cover crop it is the usual custom to water not more than once, if at all, after the fruit is harvested. This is in early summer in the sections of California from which fruit is shipped fresh. This often allows the soil to become too dry for the best development of the trees. It also causes a shortening of the growing season, on account of lack of moisture in the fall, and consequently a low food reserve for tree development and fruit production. To conserve the moisture after the winter rains and again after irrigating thorough surface cultivation to eradicate weeds cannot but prove profitable.

Where there is a hard stratum within reach of the subsoiler with open fertile soil below, subsoiling and blasting to break up this stratum are sometimes practiced with good results. Such soils are rarely suited to growing late-maturing varieties for either shipping fresh or drying for prunes.

IRRIGATION

On account of the semiarid and arid conditions prevailing in nearly all plum-growing sections of the Pacific States, irrigation is looked upon as essential in many districts and highly desirable in all. A large percentage of the area devoted to this crop is now under irrigation. Where thorough tillage is given, however, especially in the cooler sections and where the soil is naturally retentive of moisture, many growers believe that the returns from their orchards would not be sufficiently increased to justify the expense of installing irrigation systems. In a few places either insufficient water or tillable land areas too small to be suited for fruit growing make the installation of irrigation systems impracticable.

The method most commonly followed in applying water in irrigated orchards is either flooding, accompanied by checks, or admitting the water to small open ditches or furrows running parallel with the tree rows.

For irrigation where the water passes down slowly or where heavy applications are desired, as in the deep fertile soils used for prunes, flooding is more common than watering in furrows.

Ditches for irrigation are made by furrowing with a plow, and from one to a half dozen furrows are made in the space between rows. If moisture moves out freely from the furrows or water is scarce, a furrow on either side of the row is, in some cases, all that is used, but where water is plentiful and the soil such that the water percolates through it slowly more furrows are needed. On hillside plantings a furrow on the uppermost side of each row is sometimes considered sufficient. As the highest concentration of available plant food is near the surface and the soil there is best suited to root growth and activity in absorbing nutrients, the furrows for irrigation should be so close that moisture from one furrow will meet that from the next immediately below the soil mulch. In most soils water goes rapidly downward with but little lateral movement. This movement quickly carries much of the irrigation water below the feeding roots and leaves broad dry areas between the furrows if but one or two furrows are made between tree rows. A considerable portion of the soil is thus utilized but poorly, if at all, by the roots during the dry summer when the tree should be storing food at its maximum capacity. With bearing trees which have a broad spreading root system, this results in a decided handicap to the tree and consequently affects the profits from the orchard. In making furrows for irrigation, shallow ones are best on shallow or compact soils where the lateral movement of water is slow; but in deep loamy open soils where the root systems are deep and there is a free lateral movement of water through the soil, deep furrows may serve as well and provide easier handling of the water.

The frequency with which irrigation should be made and the quantity of water to be applied depend much on local soil and climatic conditions, the variety of fruit grown, the cultural practices followed in the orchard, and the prevailing price of water. When the soil is light and well subdrained and water moves rapidly downward frequent light applications are considered better than fewer heavy ones. Soil inclined to be heavy needs water less frequently and in greater quantities. In sections where water is expensive and

FIGURE 22.—A portion of an Agen (*French prune*) orchard on deep fertile soil which was irrigated in former years but not the current season. The leaves are wilting and dropping prematurely and the trees otherwise suffering from lack of moisture.

the supply limited, only one application is given in the summer, usually a short time before harvest, if the plums are for the fresh market, so that the fruit may reach the largest size possible. Where

FIGURE 23.—A portion of the orchard shown in figure 22, which has received moderate irrigation the current season. The better condition of this part of the orchard as compared with the nonirrigated part is apparent.

there is an unlimited supply of water and the charges for it are low, it is often the practice to give frequent and sometimes heavy irrigation. But under this method the soil soon becomes compact, aeration of the subsoil is hindered, and naturally an unthrifty root system develops. Where the soil is deep, moderately well drained, and irrigated water is expensive, as is the case in by far the greater part of the plum-growing sections of these States, it is the usual practice to give moderate irrigations at as widely separated intervals as conditions will permit. Four or five waterings during the summer are considered by many to be necessary. Many orchards, however, are

FIGURE 24.—An Italian Prune tree in the nonirrigated rolling section near The Dalles, Oreg., where the summers are hot and dry. An excellent soil mulch is maintained in summer by frequent tillage. In this section the tree tops are thinned out and the branches shortened by annual pruning. The trees are vigorous and productive of excellent large fruit.

maintained in a thrifty condition during the long, dry summers with only two or three waterings, followed by cultivation (figs. 22 and 23) to destroy vegetation.

Irrigation should not be substituted for cultivation to obtain thrifty trees and profitable crops in orchard, but should be resorted to for the purpose of supplementing it in order to maintain the soil moisture at the point of greatest efficiency for tree and fruit development (fig. 24). Most plum orchards, especially those where late-maturing varieties such as are used for prunes are grown, are located on soils easily tilled and naturally retentive of moisture. For such no definite rule for applying water need be given. The orchardist must judge the needs of his trees by their apparent vigor.

It must be remembered, when considering irrigation, that drying of the soil causes severe injury to the feeding roots and that frequent moistening and drying is decidedly less beneficial to the tree than keeping the soil constantly in good condition, which can be accomplished best by moderate irrigations followed by surface cultivation to destroy vegetation and aid nitrification.

Where an accumulation of alkali endangers the thrift of the tree, irrigation water may be used to decided advantage in washing out and carrying away these soluble salts, provided the soil is of such texture and slope that a good head of water can be forced across the orchard and the excess carried off in drains. In this operation the alkali-laden waters must not be allowed to accumulate in low places in the field, thereby merely shifting rather than removing the trouble.

COVER CROPS

The use of cover crops has become common but by no means universal among plum growers of the Pacific States. The need for these crops in this region is generally recognized, as the soils for the most part are low in organic matter and available nitrates. Since the summer rainfall is light, the development of moisture-retaining qualities is highly desirable. Rank-growing leguminous plants, which will furnish a large quantity of organic matter as well as store nitrogen taken from the air, are always preferred and are the only ones in general use, although the wild vegetation made up of nonleguminous plants and weeds as well as leguminous plants is sometimes allowed to grow in the orchard.

Both perennial and annual plants are grown for cover crops. In the irrigated sections of eastern Washington, eastern Oregon, and Idaho perennial crops are planted almost to the exclusion of annuals, while with but few exceptions annual plants only are used in the sections of Oregon and Washington west of the Cascade Mountains and in California. Perennial cover crops are not used in orchards where the fruit is used for prune making, as here it interferes with the fruit harvest. Among perennial cover crops alfalfa is the one in general use, although red clover is still grown in a few orchards. Alfalfa has been adopted by the larger percentage of plum and prune growers in localities where perennial cover crops are grown.

Where the soils are very fine grained and lacking in humus they become very compact under irrigation and cultivation, and the movement of irrigation water into them is naturally very slow. It is believed the filtration of irrigation water through such soil is decidedly facilitated by the growing of a permanent crop of alfalfa. At the same time, the nitrogen and humus provided by it are much needed and are responsible for increased vigor and production of the trees.

Alfalfa is not always managed as a cover crop when grown in the orchard, but sometimes as an intercrop, although planted primarily for the benefit of the trees. As it is a deep-rooted vigorous plant, it requires a deep fertile soil, such as is commonly planted to late-ripening plums. It not only will not succeed well but will result in injury to the orchard if the soil is shallow. As alfalfa requires large quantities of water, provision should be made for irrigation

before the seed is sown, or at least the ground should be leveled and the main lines for irrigation established. Whether planted in newly set orchards or in older ones, a good seedbed should be prepared for the alfalfa. It is a common custom to seed the entire surface, although planting in the areas between the rows is sometimes practiced, especially if irrigation water is not plentiful.

When the alfalfa has made some growth, it is important that the period between irrigations should not be too long. The benefit from the loosening of the soil by the alfalfa roots for the free passage of water is not apparent for the first few months after planting, although both the crop and the trees are drawing heavily upon the moisture near the surface during this time.

Water for the alfalfa crop is usually applied in from two to five furrows between rows of trees, the number depending upon the soil type and the ability of the water to pass laterally through it. The applications must be at rather frequent intervals and most often when the alfalfa is making a rapid growth after a harvest. Less water is needed after the alfalfa has reached full growth in orchards where it is not harvested but grown as a cover crop only. To give the quantity of water required for the best growth of the alfalfa may easily result in poor crops of fruit and greatly shorten the life of the orchard. An excess of subsoil moisture in orchards where alfalfa is grown is indicated by small leaves and a lack of vigor in the growth of the wood of the current season and finally by the loss of a tree here and there. On shallow or thin soils the same indications may appear, and on such soils alfalfa should not be used.

Where the alfalfa is not harvested the heavy crop of vegetation for working into the soil supplies an abundance of humus, forms an excellent mulch to protect the surface soil from drying out quickly, and maintains a more equitable temperature for root growth in the surface soil than where frequent cuttings of hay are made or clean culture is practiced. The alfalfa does not require as much water when not harvested as when frequently cut, and where fewer irrigations are necessary there is a more uniform moisture content in the soil. It is often claimed that the water necessary for the plum orchard under clean cultivation equals that where alfalfa is grown but not harvested, while the tree growth and fruit production are decidedly greater. Under clean culture, water penetration is often slow, and proportionately more irrigation water is lost by evaporation. Where cut for hay, a harvest is usually made just as the fruit is ripening, to make fruit picking easier; and where it is allowed to remain on the land, the crop is broken down with a roller or disk or cut with a mower and then worked into the surface soil, so as to be out of the way of the harvesting crews.

Where alfalfa is grown as a permanent cover crop it is necessary occasionally in most places to plow under the old crop and seed a new one. This is due, in part at least, to the alfalfa being gradually crowded out by weeds and grass which grow from seed carried in by irrigation water.

Red clover, when planted for a permanent orchard cover crop, is managed in the same way as alfalfa. On account of its shallower root system the planting of it has been almost entirely replaced by alfalfa.

Perennial cover crops are rarely grown in plum and prune orchards in western Oregon, western Washington, and California, but annual ones are planted or the growth of weeds and other plants that develop without hand seeding is encouraged in most orchards. Vetch, melilotus, and horsebean are the most favored crops for planting in these sections. Oats, barley, or some other small grain is sometimes planted as a cover or soiling crop, either by itself or with vetch to support it in the spring and to prevent its being blown down or lodged by rain. Except for the purposes just mentioned, small grains and grasses are not recommended as cover crops in the plum section of the Pacific States if leguminous or other more suitable plants can be grown successfully. Bur-clover is among the most commonly grown plants adapted to a wide range of soils and well suited to the climatic conditions of the plum-growing regions of California. It is a vigorous grower, easy to manage, a very satisfactory cover crop, and may be plowed under during the spring like other annual cover crops. To perpetuate it without the expense of reseeding, occasional plants are allowed to remain undisturbed, or the tips are left uncovered when plowing. These blossom and ripen seed, which remains in the ground for growth the next fall.

Annual crops are sown late in the summer, sometimes immediately after the first fall rain, or, if rains are late, after an irrigation. To insure quick germination the seed is often sown on the surface and not worked into the soil. If covered, a portion of the seed may not germinate until the following spring, possibly too late for the plants to make a satisfactory growth before plowing. After seeding no further attention is given the cover crop, as the fall and winter rains are usually sufficient for a good plant growth. When the winter and early spring temperatures are moderate, a good growth is usually made by the cover crop; but if the growth has been slow, spring plowing is sometimes delayed for a few days after the soil has become sufficiently dry for plowing to permit the growth of the cover crop. This practice, however, is often attended with injurious results.

A poor growth of the cover crop is often noticed in old orchards where clean cultivation has been practiced for a number of years and in localities where the soil is lacking in available nitrogen. A number of places have been observed where the growth was exceedingly poor except in portions of the orchard where stable manure or commercial fertilizers had been applied. In those places a rank thrifty-growing crop was found.

INTERCROPS

Intercropping is often practiced in plum orchards on high-priced land. Among annual crops beans, corn, pumpkins, and garden crops are planted extensively, usually profitably, even where the soil is of only moderate depth, if water is plentiful and good soil management practiced. Where such crops are grown the results indicate that they are decidedly preferable to small grains and grasses. Aside from alfalfa, the perennial crops used for interplanting with plums include hops, walnuts, other deciduous fruits, and berries (figs. 25 and 26). Each of these crops is confined to a more or less restricted set of conditions, and all need fertile soils. Hops are sometimes planted at the same time as the prune trees, or if prunes are planted in the hop field,

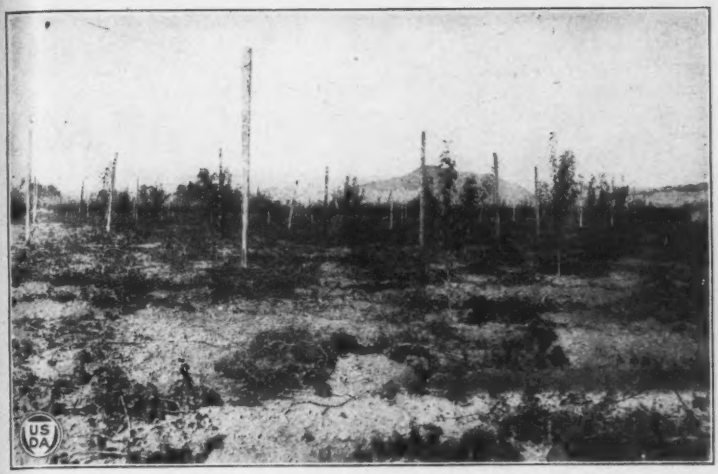

FIGURE 25.—A 2-year-old Agen (*French prune*) orchard interplanted with hops in California. The hop harvest had just been completed.

the hops are allowed to remain until the trees are a few years old. The time for removing them depends on the relative value of the two crops, but they should not be left longer than 4 or 5 years after the

FIGURE 26.—A young Agen (*French prune*) orchard with an intercrop of winter cauliflower. Santa Clara Valley.

prunes are planted. This practice is most common in some of the warm valleys of California, where a substitute for hops is sought. Where Persian walnuts are planted with plums it is usually the plan

to remove the plums when the walnuts have come into bearing. This plan is also followed with other deciduous fruits, but sometimes both crops are planted with a view to deciding which shall be the permanent orchard when both have come into bearing. The use of vegetables and berries as intercrops is usually discontinued when the plum trees approach full bearing.

PRUNING

At the time of setting in the orchard, the nursery tree, which is usually a whip, is cut back to a bud where the uppermost branch for forming the head is desired. This height varies greatly with different growers and with the variety and the purpose for which it is grown. With those grown for their fresh fruit, 2½ feet is about the height preferred for cutting back the young tree, particularly those which

FIGURE 27.—High-headed Italian Prune trees intercropped with potatoes. Clark County, Wash.

are most inclined to be upright in growth, such as most Japanese varieties. The same height, or even a lower head, is favored by growers of the Agen (*French prune*), especially in California. In States farther north, where the Italian Prune, a comparatively spreading tree, is the important variety, the nursery tree is cut back to a height of 3 to 3½ feet or even more for the formation of the tree head (fig. 27). The height at which the branches are to produced should be determined by the habits of the variety (whether spreading or upright), by the implements to be used in cultivation, and by the disposition to be made of the fruit. If the fruit is for fresh shipment, low branches make the harvest easier; but for growing prunes, where the fruit is shaken from the trees, the formation of the tree head may be somewhat higher without particular disadvantage except that the danger of injury by sunburn on the trunk is increased.

Three branches are usually desired for forming the lower framework of the tree, although some growers prefer four or five. These branches are selected from among those growing from the upper part

of the trunk, care being taken to select strong branches separated by several inches along the trunk and at distances as nearly equal as possible around it.

Where these main branches are allowed to grow near the same point on the trunk, a pocket which will hold water and collect dust, falling fruit, and leaves is often formed within a few years by the increasing diameter of the branches. Here wood-rotting organisms enter easily, and the loss of many limbs and the weakening of others result, so that they are easily broken down by heavy loads of fruit or by windstorms. Where four or five main branches are allowed to grow in forming the tree, the danger of the formation of such a pocket is obviously increased (fig. 28).

FIGURE 28.—A plum tree composed of several main limbs which started from points close together on the trunk. As the limbs increased in size a pocket was formed where they came together. Wood-decaying organisms found entrance here, thus weakening the limbs, some of which have broken down.

To induce further branching of the young tree, the limbs which develop the first season after the tree is planted are, in turn, cut back the following winter, or they may be lightly pinched back during the summer when they have reached the desired length. The same practice is followed in succeeding years to induce further branching.

Superfluous branches should be rubbed off when they first appear, or they should be removed not later than the winter after their first season's growth. In selecting the branches which are to remain, much can be done toward directing the shape of the tree and developing a formation that will enable it to hold heavy crops of fruit. Where too many branches are left or some have grown at an undesired angle they may be removed, so as not to interfere with the best development of the tree.

With top-grafted trees, much can be done toward establishing the framework the first year, as at this time the new wood makes a

vigorous, rampant growth and may be pinched back three or four times during the summer, thus establishing as many points of branching (fig. 29). Such pinching back causes the growth of a great number of branches, and those not needed may be removed when

FIGURE 29.—Three-year-old President plum grafts top-worked on a peach tree. The new plum growth was pinched back three or four times during the first season after grafting. This caused the growth of many branches that season, some of which should be removed.

they appear or may be left until the regular time for pruning during the dormant season.

Many have followed the custom of severely heading back all varieties of plums each winter until a considerable production of

fruit is reached, in order to favor the development of a stocky vigorous tree, but this system is being gradually abandoned except for the first year, after which the branches are only thinned out or cut to laterals to form a more open tree. In this way the young tree makes a greater growth and comes to bearing earlier than where severely cut back each winter. The practice of cutting back to laterals and removing only superflous branches is coming into more general favor on irrigated lands where soils are fertile and a thrifty new growth is assured. The old method of pruning is still used in some sections, especially in nonirrigated orchards where new growth is slow and for some varieties which are spreading in their habits of growth, grow slowly, and are not naturally vigorous.

In the pruning of bearing trees there is considerable divergence in practice. With varieties grown for prunes the branches, as a rule, are thinned out rather than cut back, and in many instances no pruning is performed or only dead branches are removed. Where the trees are grown for the fresh fruit, more thinning out is done with many varieties, especially the Japanese sorts, and in some sections severe annual cutting back is customary. On the thinner and poorer soils and in nonirrigated sections the practice of cutting back the 1-year wood is more general than elsewhere. Methods favored or particularly successful in one locality are naturally carried into neighboring ones, although conditions for wood growth there may be decidedly different and poor results may follow. The annual wood growth is normally short on the drier soils; on all but the deeper soil types in such places varieties for the production of fresh fruit are grown. Good prices for the fruit can be realized on large sizes only, and severe cutting back of the previous season's wood growth is relied on to insure large sizes of fruit. In some dry places where the annual growth is normally short, even on heavily pruned trees, if cutting back is not practiced it will be exceedingly short after a year or so, and poor production and lack of vigor in the tree may be expected.

On irrigated soils which are considered insufficiently deep for planting to varieties for prune making but where plums for fresh shipment are grown extensively, cutting back the new wood is widely practiced. Under these conditions some growers cut back lightly the growth of the previous year and with varieties of the domestica group confine their pruning mostly to the thinning out of branches. With the Japanese plums, which are naturally vigorous growers and bear their fruit on spurs on wood of all ages, more cutting back of 1-year-old wood, as well as the thinning out of branches, is practiced, to insure a vigorous wood growth and large-sized fruit. In this instance pruning is used partly as a means of thinning the fruit or, rather, of reducing the crop and distributing the load over the tree. Where heavy cutting back is practiced the trees are called upon to produce a crop of both wood and fruit. The soil cannot be expected to sustain a profitable orchard where the toll for each is heavy.

Trees of the Agen and Italian Prune, the two principal varieties grown for prune production, bear most of their fruit on wood 1 and 2 years of age. A thrifty wood growth should therefore be made by the tree each year. If not thinned out or occasionally cut back, the twigs soon become too numerous for the tree to produce a satisfac-

tory terminal growth, and a poor terminal growth results in small or irregular crops of fruit. On the other hand, removing too much bearing wood will naturally prevent a good crop the following year. Under conditions most favorable for wood growth by varieties which naturally make a strong growth, less thinning out of the twigs will be necessary. Where thinning out the branches and occasionally cutting the terminal growth back to laterals is not sufficient to induce the growth of several inches of vigorous new wood at the ends of the twigs during the summer, a change in methods of culture should be resorted to for stimulating more vigorous growth.

The growing and fruiting habits of the individual varieties should be closely observed and should guide the pruner in his work. Varieties inclined to make a compact upright growth, such as the Santa Rosa or Wickson, should be pruned to induce spreading. Those naturally spreading, such as the Burbank, should have their long lateral-growing branches shortened to facilitate cultivation and to encourage the growth of strong upright branches which can carry a heavy load of fruit and provide shelter from the sun for the main trunk. Varieties which bear fruit on spurs on older wood should be kept open for the admission of sufficient light to develop fully the foliage of such spurs. This can be accomplished best by moderately thinning out the new wood. Severe cutting back will result in a vigorous new growth, which tends to shade and prevent spur development. Too little pruning, on the other hand, often results in the stagnation of growth of these spur-forming varieties, with consequent poor production. Excessive pruning of the upright-growing varieties of Japanese plums causes a rampant growth and a tendency to form long barren poles, on which fruitfulness is delayed, even if spurs form on them at all. Among varieties which under good growing conditions make some terminal growth on which they bear most of their fruit the following year there are variations in tendencies which should not be overlooked in pruning. Excessive cutting back will cause a heavy new growth with these as with other varieties, while no pruning tends to cause the formation of spurs and inactivity of growth of such spurs. This occurs at least on varieties or individual trees where little or no terminal growth is made, with a resulting decrease in fruit production. With the dying out of some spurs and the loss of others broken off in harvest and cultivation, the fruit-producing portion of the tree is seriously reduced year by year. This is naturally most apparent where the orchards are on poor soils or where there is a shortage of soil moisture.

With some varieties a short terminal growth with occasional branching continues without the formation of spurs or any upright vigorous growth, and gradually long, slender, drooping masses of unfruitful twigs will develop. Trees of the Italian Prune often illustrate this. These differences in habits in the growth of wood and fruit spurs may be well illustrated by the Agen and Pond varieties, and by the Giant, which is a cross between them. The Agen variety, if left unpruned, will continue the growth of all its branches with a gradually shortening annual wood growth, and at the same time the fruit gradually will decrease in size, provided good crops are matured. When left unpruned the Pond will quickly stop its terminal growth. The dying out of many spurs and the poor leaf growth of

others exposes the fruit and wood to the sun, often resulting in sunburning. The Giant, although losing some of its spurs, will continue a fairly vigorous growth of all its terminal branches and twigs and produce a good crop of normal-sized fruit.

It should be remembered in all pruning that the work should be carefully performed with sharp tools. Where a wound is made which will not heal over quickly, as when a stub is left that is too long, or split branches are not removed, or where the bark is torn or a wound left by the removal of a large branch, there is danger of the entrance of wood-decaying organisms. The careful selection of branches when shaping the young tree and later in pruning, so as to make unnecessary the cutting out of large branches, and the careful manipulation of pruning tools will prevent serious losses later.

FRUIT THINNING

Thinning the fruit is often important in plum culture. It is seldom practiced where the fruit is grown for prunes, but most varieties cultivated for their fresh fruit require it. Thinning is done primarily for the purpose of allowing the fruit which remains on the tree to become larger, so that higher prices may be received for it, but thinning also relieves the tree of some of its weight and tends to prevent the breaking of branches and to reduce the number of crops required, thereby better enabling the tree to bear regular crops of fruit. Pruning out superfluous twigs during the dormant season and also after the fruit has set is a cheap and efficient means of decreasing the load of fruit, but hand thinning, in order to leave the fruit properly spaced on the tree, is often necessary. Hand thinning should be done as soon as all danger of spring frosts is over, so that the tree may be relieved of its excessive burden as early as possible.

Thinning is necessary almost every season with some varieties of the Japanese group, such as Beauty and Burbank, and is less so with many varieties of the domestica group.

PROPPING AND BRACING

Artificial supports are often necessary to prevent the breaking down of fruit-laden branches. Slender boards are used for this purpose and are put in place when the branches start to bend with their burden of fruit.

Wires to fasten opposite branches together, thus preventing their being broken by loads of fruit, are used in a number of orchards. This means of support is considered by many a satisfactory substitute for the use of wooden props. A number of methods of using wire for supporting branches are employed, the most common being to fasten a small wire to the large branches and connect them to a ring in the center of the tree. If it is not convenient to fasten the outer branches to the center ring they may be wired to a branch which has been given support. Connecting the outer branches with a wire without the use of a ring in the center is a method favored by some.

The use of wire supports has the advantage of requiring but a small outlay for material, is fairly permanent, and does not interfere with cultivation, irrigation, and fruit picking, as do wooden

props. There is often loss of branches by breaking where props are loosened and fall when strong winds sway the trees. This is avoided by the use of wires.

Where weakness is found, occasioned by an unsatisfactory crotch, or where a large limb has been partially split down, long bolts put through the trunk or limb have been used for giving permanent support.

The necessity of branch supports may be partly eliminated by pruning, so that wounds will heal quickly and in a manner to develop a strong framework, by thinning the fruit, and by preventing injuries to the tree from sunscald and wood decays.

FERTILIZERS

Wherever animal manures have been applied to plum orchards in the Pacific States excellent results have followed. Owing to the shortage of such fertilizers, however, comparatively few orchards have been so treated. Quickly available forms of nitrogen are used by some growers to improve tree growth and to increase the size of the fruit. They have also been used in a number of instances to cause a heavier setting of fruit. For this purpose fertilizer is broadcast about the trees 3 or 4 weeks before the blossoms appear. Many growers claim that decided benefits have followed from this treatment.

FRUIT HARVEST

The plum harvest starts as soon as fruit enough to warrant a shipment reaches sufficient maturity to ripen while in transit to the market. This is late in May for the earliest varieties in some sections of California. The harvest of other varieties continues until August in that State and until late in September in some places in Washingon where summer temperatures are lower. With some of the Japanese varieties, the fruit of which is very juicy and therefore easily bruised, little delay can be allowed for harvesting after the fruit reaches shipping condition. Many of the domestica varieties, however, have a texture which enables them to become nearly ripe on the tree and still reach distant markets in good condition. Fruit that ripens slowly in sections where summer temperatures are moderate or low is sometimes allowed to remain on the tree for a period after reaching maturity, without injuring it for market.

Under average conditions plums ripen unevenly over the tree. Therefore two or three pickings must be made, although one or two may be sufficient for varieties where the fruit is allowed to become well ripened before picking. Harvests are usually 3 or 4 days apart, but this period is determined by weather conditions and the variety.

As badly bruised fruits and those with broken skins are not suitable for shipment, care must be exercised in picking and packing the fruit. In harvesting, the pickers take the fruit from the tree by hand and place it in baskets or buckets for hauling to the packing house. Light ladders are used for reaching the fruit on the tall branches.

In the packing shed where the fruit is to be graded by hand it is very carefully poured into bins on packing tables, where it is sorted to size and defective plums are removed as the fruit is placed in the containers for shipment. This sorting requires considerable

time, and often much of the bloom that covers the plums is rubbed off, seriously detracting from the appearance of the fruit. Excellent packages, however, are often put up where the grading is done by hand. Machines for grading plums to size rapidly and with but little if any serious bruising have come into common use.

For shipping the fruit a crate holding four tin-rimmed veneer baskets is the container most commonly used in California, although crates, fruit boxes, and lug boxes of different sizes are also used. In Idaho the half-bushel basket has largely replaced other containers. In central Washington the major part of the crop is shipped in the 16-pound lug box.

As a rule, each orchard or farm has its own packing house, which is conveniently situated in or near the orchard where the fruit is

FIGURE 30.—A 3-tunnel drier typical of those used by many prune growers in the Northwestern States.

packed and loaded on trucks for transporting to the shipping station, although a number of packing houses designed for packing fruit from several orchards are operated during the fruit-packing season.

Laws regarding the quality of fresh fruit and the shipping containers are operative in each of the Pacific States and enforced by county, district, or State officials.

The prune harvest is more cheaply and quickly accomplished and with less care than is the plum harvest. The fruit is allowed to remain on the tree until it is thoroughly ripe and is falling off of its own accord. Where jarring is necessary to cause the fruit to fall, it is done by striking the branches with light poles or padded clubs. The fruit is gathered by hand from the ground or canvas on which it falls and is placed in lug boxes for hauling to the drying yard.

Owing to the natural humidity and fall rains, the entire output of prunes in Washington, Oregon, and Idaho must be dried artificially.

In California the period during which prunes are dried is usually hot and dry, and about one-half of the crop is cured in the sun (figs. 30, 31, and 32). During recent years artificial evaporation has come into extensive use there as an insurance against the loss of fruit from rain. This method of drying is thought to be somewhat more ex-

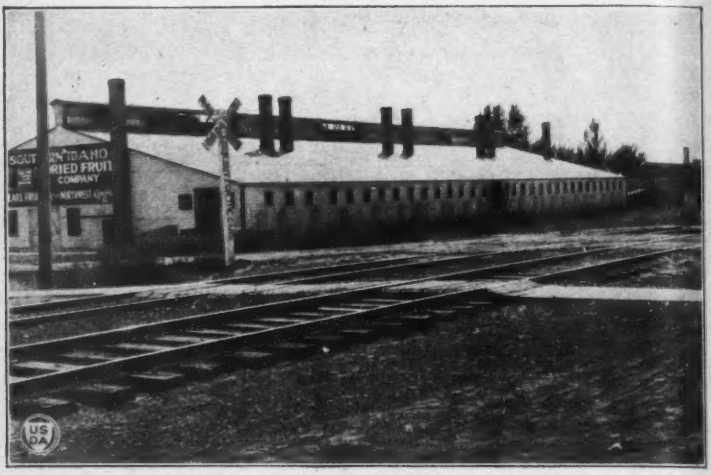

FIGURE 31.—A modern large-capacity prune drier and processing house combined. (Idaho.)

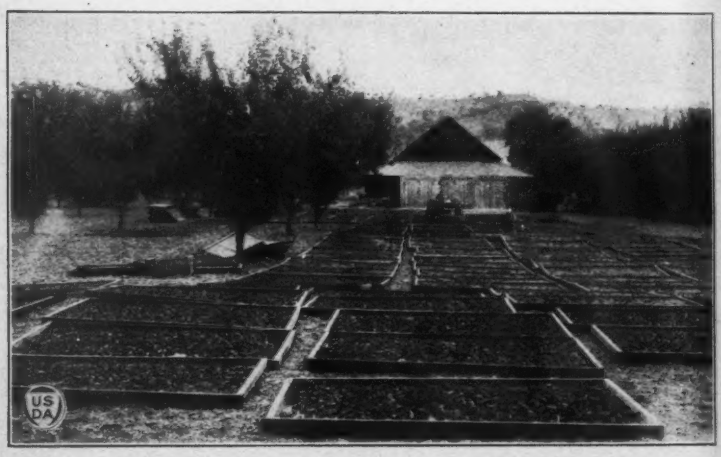

FIGURE 32.—A prune-drying yard in central California.

pensive than open-air drying, but in case of early fall rains it enables the grower to dry his crop without the loss of fruit. It also permits

the use of dry yards for orchard or other purposes and, when properly carried out, gives a more uniform and cleaner product. The practice is increasing. About half of the State's prune output is now handled in modern mechanical dehydrators. After drying, the fruit is taken to the processors to be prepared for market.

DISEASES AND INSECTS

A number of diseases and insects attack the plum and prune in the Pacific States. They are amenable to control or preventive measures, with which the grower should become familiar in anticipation of having eventually to make use of them.

The principal diseases include brown rot, which causes decay of the fruit and may affect the small twigs and spurs, or even the blossoms; leaf spot and shot hole fungus, which attacks the leaves; and heart rot and oak root fungi, which attack the tree. Other diseases may occur, but those mentioned are usually the most common.

The diseases affecting the fruit and foliage are held in check by spraying; those affecting the woody parts of the tree are subject to preventive methods only.

Heart rot is a rather general term commonly applied to the results of wood-decaying organisms which find entrance to the heart of the tree through long stubs left in pruning, bad crotches, or pockets resulting from improperly formed tree tops, or wounds made in other ways. Preventive measures consist obviously in avoiding or eliminating those means through which the fungi causing decay enter the tree.

Oak root fungus is common on roots of oaks indigenous to some of the fruit districts of the Pacific States. The roots of many fruit trees are likewise susceptible to this disease. Where it occurs the only practicable course is to leave the infected areas unplanted or to plant pears propagated on French roots or figs (where these fruits are adapted), since these are about the only fruits resistant to this disease. California black walnuts are sometimes planted in such instances, to be top-worked later to the Persian walnuts.

Among the most destructive insects that attack plums and prunes in the Pacific States are the peach-tree borer, San Jose scale, red spider, thrips, twig borer, brown apricot scale, and black scale. These, with a few of less general importance, cause heavy losses annually to the plum and prune producing industry.

As climatic and other conditions vary greatly in different regions and localities, the plum grower should apply to his State agricultural experiment station for advice regarding preventive and remedial measures to be employed for the control of injurious insects and diseases with which he is likely to have to contend. Information may also be obtained from the United States Department of Agriculture.

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